DEC 2 - 1931

PRODUCT ENGINEERING

Devoted to Product Creation, Design and Improvement
McGRAW-HILL PUBLISHING COMPANY, INC.
Price 25 cents

Business may be momentarily disorganized; distribution of products and wealth may need drastic rehabilitation

•

But history will prove the soundness and the basic humanity of the machine age

•

New products and the improvement of old ones will continue to make life more livable, and the product engineer will be recognized in the key position he occupies in the new civilization

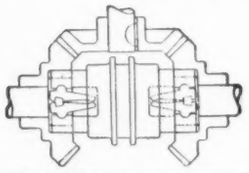
+ DECEMBER +
1931

THE JOHNSON FRICTION CLUTCH

Use The NEW

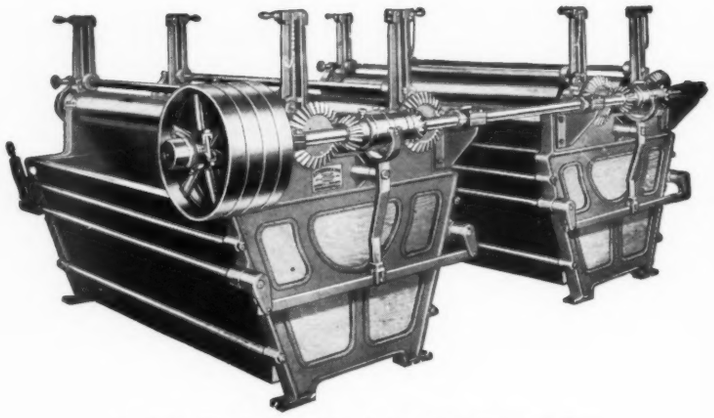
SUPER-JOHNSON CLUTCH BETWEEN BEVEL GEARING

where such an installation is required and GIVE USERS EXTREME SATISFACTION

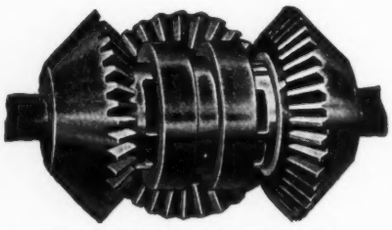


Double Clutch in nest of gearing

The SUPER-JOHNSON Clutch between bevel gearing gives perfect forward and reverse operation. The simple construction of the SUPER-JOHNSON makes it an excellent choice for vertical installations — there are no discs to stick.

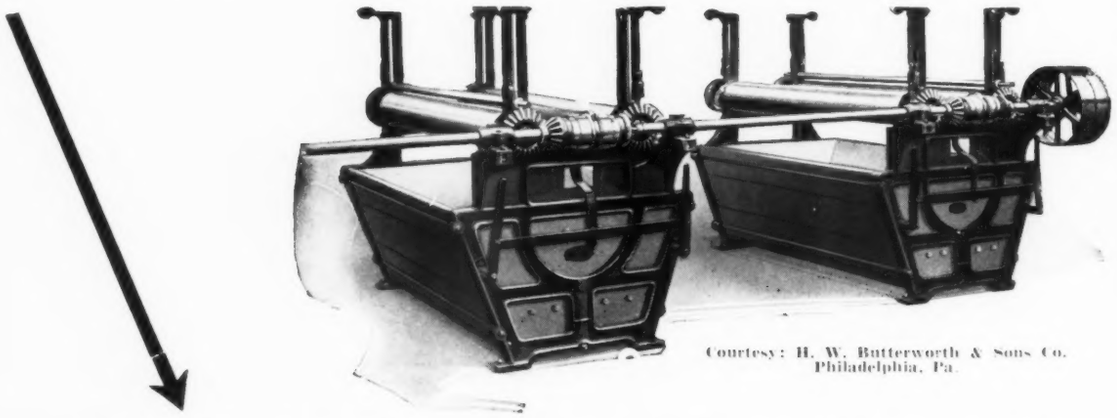


Courtesy: The B. F. Perkins & Son, Inc., Holyoke, Mass.



Double Clutch Between Bevel Gears

Try this double clutch on your particular type of machine and prove our claims. The SUPER-JOHNSON is designed to work efficiently under high speeds, heavy starting loads, excessive slipping, and continuous engaging.



Courtesy: H. W. Butterworth & Sons Co. Philadelphia, Pa.

SEND FOR CATALOG "PE-12"

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER CONN.

PRODUCT ENGINEERING

Devoted to the Interests of Engineers and Executives Responsible for Product Creation, Design and Improvement

FRED H. COLVIN
Consulting Editor
G. F. NORDENHOLT
H. R. LE GRAND

KENNETH H. CONDIT, *Editor and Publishing Director*
GEORGE S. BRADY, *Managing Editor*

FRANK J. OLIVER, JR.
Chicago
E. J. TANGERMAN
C. G. SMITH

Contents for December, 1931

VOLUME 2 . . . NUMBER 12

Copyright, 1931, by the McGraw-Hill Publishing Company, Inc.

Heat-Radiating Capacity of Clutches and Brakes 529
A. C. RASMUSSEN

Trends in Product Engineering 533
A Glance at New Products

Mechanical Transmission of Power Between Moving Elements. 537
Applied Mechanisms

A New Industry Out of An Old Product 538
R. FAWN MITCHELL

Isolating Vibrations with Rubber 542
F. L. HAUSHALTER

Aluminum Parts for Aluminum Structures 546
SETH G. MALBY

Organizing a Product Development Program 548
An Analysis

Corrosion-Resistant and Insulating Materials Featured in Dairy Machinery 550
GEORGE S. BRADY

How to Design for Hydraulic Operation 553
H. F. VICKERS

Mechanical Forces Measured Electrically 558
IRVING J. SAXL

BOOKS FOR ENGINEERS 532
EDITORIALS 556
REFERENCE BOOK SHEETS 561
COMMENT AND SUGGESTION 563
WHAT'S GOING ON 566
NEW MATERIALS AND PARTS 570

(INDEX TO VOLUME 2)

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42D STREET, NEW YORK, N. Y.

CHICAGO, 520 N. Michigan Ave.

CABLE ADDRESS: "MACHINIST, N. Y."
Aldwych House, Aldwych
LONDON, W.C. 2

883 Mission St., SAN FRANCISCO

JAMES H. McGRAW, Chairman of the Board
MALCOLM MUIR, President
JAMES H. McGRAW, JR., Vice-Pres. and Treas.
MASON BRITTON, Vice-President
EDGAR KOBAK, Vice-President
H. C. PARMELEE, Vice-Pres. and Editorial Director
HAROLD W. McGRAW, Vice-President
C. H. THOMPSON, Secretary

Published monthly. $2 per year, 25 cents per copy. Canada, $2.50, including duty. Entered as second-class matter, January 17, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

Number of copies printed this issue, 10,000
Number of paid subscribers, Nov. 16, 1931, 8,515

WASHINGTON, National Press Building
PHILADELPHIA, 1600 Arch Street
CLEVELAND, 501 Guardian Building
DETROIT, 2-257 General Motors Building
ST. LOUIS, 1556 Bell Telephone Building
BOSTON, 1427 Statler Building
GREENVILLE, S. C., 1301 Woodside Building
LOS ANGELES, 339 Chamber of Commerce Building

"HUMAN ERROR is a waste factor that modern business must reduce to an absolute minimum."

ETHAN BATES STANLEY, *President*
The American Laundry Machinery Co.

• • There will always be human error in every operation that is done by hand or that is thought out. Machinery on the other hand makes no mistakes. It travels a given path without error.

• • Nearly every machine originated in someone's seeing where human effort and its attending error could be lessened. Many manual operations remain only until someone sees, in his mind, the machine which will make them unnecessary.

• • Certain men are able to see these things. They have engineering minds trained to look for better ways to do things, for ways requiring little effort, for ways permitting no error. These men are today's real product engineers.

• • There is no one man in better position to lead his company to real prosperity than the product engineer who can eliminate human effort and error with the machine he engineers.

▼

• PRODUCT ENGINEERING •

PRODUCT ENGINEERING

McGRAW-HILL PUBLISHING COMPANY, INC. DECEMBER 1931 VOL. 2, No. 12

Heat-Radiating Capacity of Clutches and Brakes

By A. C. RASMUSSEN

Mechanical Engineer

For certain classes of service, the design of clutches or brakes must be based on heat-radiating capacity in order to avoid excessive temperatures. Overheating usually causes a reduction of the coefficient of friction and disintegration of the friction material. The author presents formulas and design constants for the calculation of brakes and clutches

HOISTING engines and excavating machines of the shovel or reciprocating digger type employ friction clutches for the purpose of bringing the speed of the load or the digging attachment up to the more or less constant speed produced by the engine. This is particularly true where gasoline engines are used for the motive power and a governor maintains an established engine speed. With such machinery the clutch is used continuously, being engaged and disengaged repeatedly, many times a minute. Considerable heat is generated as a result of the repeated slipping of the clutch when being engaged. The brakes operate at about the same rate of intermittent application and likewise tend to become very hot. Ample provision must be made for the radiation of this heat.

The commonly used equations for designing a clutch or a brake are for calculating the torque capacity. In these formulas no consideration is given to the rate of heat dissipation. After the dimensions are determined by such conventional formulas the design must be modified in order to provide ample radiating surface.

By using the formulas which are based on the heat dissipation capacity rather than the torque capacity, calculations can be greatly shortened.

The amount of power which is absorbed by the clutch during the slipping in bringing the mechanism up to speed, or by the brake in stopping the moving parts, is converted into units of heat, and it is this heat that must be dissipated by the exposed metal surfaces of the clutch or the brake to avoid building up excess temperature.

The horsepower transmitted by a clutch or absorbed by a brake is:

$$HP = \frac{F\,V}{33{,}000} \qquad (1)$$

in which F = lb. rim force at mean radius, r
V = velocity in ft. per min. at the mean radius, r

$$V = \frac{2\pi r n}{12}$$

in which n = r.p.m. of shaft

In the foregoing, rim force, F, is the product

of the unit pressure p on the friction surface, the coefficient of friction u and the area of engagement A in sq.in.

$$F = up\,A$$

Therefore:

$$HP = \frac{up\,A\,2\pi rn}{33{,}000 \times 12}$$

$$= \frac{uprn}{63{,}025} A$$

Horsepower represents a definite amount of energy transmitted per minute and if dissipated as heat by a brake or by a slipping clutch, the amount of heat dissipated per minute also is definite, a hp. being equal to 42.57 b.t.u. per min. Therefore, for a given amount of power transmitted per sq.in. of friction surface, a definite amount of heat must be dissipated per sq.in., if the temperature is to remain within safe limits.

Upon the foregoing hypothesis the horsepower capacity of a clutch or a brake is dependent upon the friction area and the capacity can be considered as so much hp. per sq.in. of friction surface. Calling this amount of horsepower per square inch, M, then

$$M = \frac{HP}{A} = \frac{uprn}{63{,}025}$$

or,

$$HP = M\,A$$

The experience which the writer has had with clutches and brakes on excavating machinery has been that the following values of M for clutches and brakes are approximately correct. The values given are based on using the horsepower delivered to the shaft by the engine. The full power of the shaft is often used to bring the load or the digging attachment up to the operating speed. The brakes absorb approximately the same amount of energy, particularly in crane service.

For open, exposed band and cone clutches,

M = 0.25 to 0.40 hp. per sq.in. of area of contact

For open, exposed band brakes,

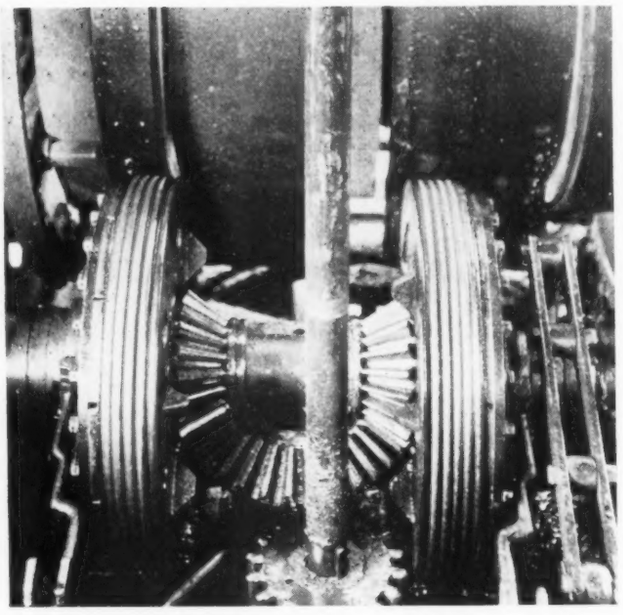
M = 0.20 to 0.30 hp. per sq.in. of area of contact

Clutches or brakes that are partially inclosed or are covered by guards or overlapping structure in such a way as to restrict the free flow of air will not cool so readily and lower values for M should be used.

The following formulas are derived by using the above equation.

With a band clutch or a band brake the wrap is not 360 deg. Let k represent the proportion of wrap, or expressed as an equation, we have:

$$k = \frac{\text{angle of wrap}}{360^\circ}$$



FRICTION clutches for a reversing gear, showing corrugated outer surface of band to increase heat radiating capacity

Let d = mean diameter

b = width of friction lining

Then $A = \pi kbd$

Repeating equation (1)

$$HP = \frac{FV}{33{,}000} = \frac{up\,AV}{33{,}000}$$

Represent up by C, the average force of friction per sq.in. of area.

$$HP = \frac{C\,A\,V}{33{,}000} = M\,A$$

or

$$CV = 33{,}000\,M = C\frac{\pi dn}{12}$$

or

$$C = \frac{396{,}000\,M}{\pi dn} \text{ lb. per sq.in.}$$

Torque,

$$T = \frac{C\,A\,d}{2} = \frac{198{,}000\,M\,kbd}{n} \text{ lb. in.}$$

Rim force,

$$R = C\,A = \frac{396{,}000\,M\,kb}{n} \text{ lb.}$$

In the design of a clutch or a brake for which $M = 0.25$, we have:

$$HP = 0.25\,A \qquad (2)$$

$$= 0.7854\,kbd \qquad (3)$$

$$C = \frac{31{,}512}{dn} \text{ lb. per sq.in.} \qquad (4)$$

$$\text{Torque,} \quad T = \frac{49{,}500\ kbd}{n} \text{ lb. in.} \tag{5}$$

$$\text{Rim force,} \quad R = \frac{99{,}000\ kb}{n} \text{ lb.} \tag{6}$$

Reduced equations such as (2) to (6) inclusive can be solved for other values of M and are more convenient to use than to be handling continually M as a numerical value in solving the equations.

The following relationships are shown directly in the above equations, and are of great assistance when selecting brake proportions.

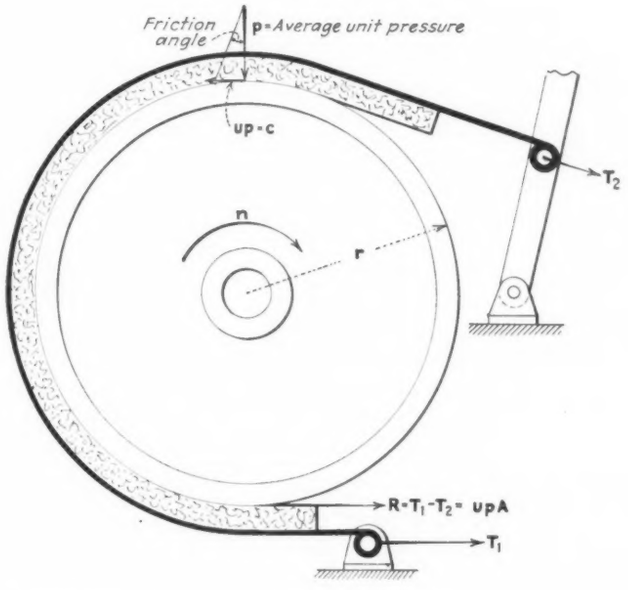
Equation (3). The horsepower capacity of a clutch can be increased or decreased by changing b or d, or both.

Equation (4). For a given speed of rotation, the average unit pressure p can be reduced by increasing d and vice versa, because:

$$p = \frac{C}{u} \tag{7}$$

Equation (5). Assuming that the speed of rotation is established, the torque capacity, T, is increased or decreased by changing b or d or both.

Equation (6). The rim force found by this equation is used in band clutch and band brake calculations for determining the pull required on the free end for operation. The pull on the fixed or anchored end is also calculated from this same value. Should these forces prove to be excessive the width of the band must be decreased.



ELEMENTS of a band brake showing the factors that determine its proper proportioning

Consequently the diameter must be proportionately increased to maintain the same capacity.

In determining the size of a clutch or a brake, the approximate diameter d is obtained from knowledge of the size of adjacent parts. The width b is then arbitrarily chosen. Equation (3) is used to determine if these dimensions are sufficient to give proper horsepower capacity. Equation (6) is then used to determine the rim force R resulting from the width selected.

Equation (4) is used as a check to guard against using an excessive pressure, p, the value of which is found from Equation (7). The value of C as found from Equation (4) is the average force of friction over the full contact area. With a band clutch or band brake, the force of friction is greater at the fixed or anchored end and less at the free end. The usual band brake formulas are used to calculate the tension at each end, in which formulas the tangential force at the rim is the rim force, R, as found by Equation (6). It is used as the difference between the fixed-end tension and the free-end tension.

Let T_1 = fixed end tension
T_2 = free end tension
Then $R = T_1 - T_2$ (8)

The maximum pressure on the friction surface occurs at the fixed end of the band and may be calculated to determine if this pressure is excessive for the lining. The maximum unit pressure, p, is found as follows:

$$p_1 = \frac{2T_1}{bd} \tag{9}$$

The minimum unit pressure, p_2 occurring at the free end is found thus:

$$p_2 = \frac{2T_2}{bd} \tag{10}$$

Manufacturers of friction lining material produce many different kinds and grades. No attempt can be made here to give the recommended limits for unit pressure for the different materials. However, the following figures show approximately the loads which have been successfully used for several types of material and may be considered as the maximum pressures of engagement per square inch.

Molded compressed friction blocks	200 lb. per sq.in.
Molded band friction lining	150 lb. per sq.in.
Woven and compressed friction lining	100 lb. per sq.in.
Folded and compressed friction lining	100 lb. per sq.in.

The foregoing figures are for construction

equipment where the available space limits the size of clutches and brakes and more frequent replacements are permitted. For more permanent installations about 50 per cent of these loads should be used.

Linings of flexible material are usually fastened in place with brass rivets. Copper rivets are sometimes used but are objectionable because they cause scoring of the metal friction drum when the linings are worn down to where the rivet heads rub. Aluminum rivets are soft and do not score the drum, but they lack shear strength particularly when heated to the temperatures usually prevailing during continuous operation of the clutch or brake. Linings of hard molded blocks are sometimes fastened in place with steel bolts, although large size brass rivets are probably safer to use in order to avoid scoring the drums.

Where trouble is experienced with linings becoming torn loose on account of hard service, an effective remedy is to cement the band in place in addition to the use of a fewer number of rivets, thereby avoiding the reduction of the friction surface area as would result from the use of an excessive number of rivets. Muffle furnace cement of the air-drying kind, containing water glass, is used for this purpose as it stands the heat without deterioration.

Brass has an ultimate shearing strength of 36,000 lb. per sq.in., approximately. Figuring a safe shearing strength of 12,000 lb. per sq.in., rivet strengths shown in the accompanying table are obtained.

Safe Shear Strength of Brass Rivets	
$\frac{5}{16}$ in. dia.	920 lb.
$\frac{1}{4}$ in. dia.	600 lb.
$\frac{3}{16}$ in. dia.	330 lb.
$\frac{1}{8}$ in. dia.	150 lb.

The number of rivets to use in a lining will depend on the friction material used. Molded band friction lining, for example, has a maximum pressure of engagement of 150 lb. per sq.in. It may have a maximum coefficient of friction u of 0.55. Therefore the maximum friction of engagement will be 83 lb. per sq.in. Using $\frac{3}{16}$ in. dia. brass rivets, as 330 divided by 83 equals approximately 4.0 sq.in., one rivet is required for each 4 sq.in. of friction area.

BOOKS FOR ENGINEERS

PLASTICITY. *By A. Nadai, Dr. Ing., assisted by A. M. Wahl, M.S., both of the Research Laboratories of the Westinghouse Electric & Manufacturing Company. 349 pages, 6x9 in. 397 illustrations. Cloth-board covers. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York, N. Y. Price $5.*

SELECTION of Dr. Nadai's book as the first of the Engineering Society Monographs sponsored by four national engineering societies, the American Society of Civil Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, and the American Society of Mechanical Engineers, was a splendid choice. Not only is the book the first of its kind in the English language, but it is also the work of the outstanding authority, and deals with a subject that can no longer be ignored by engineers.

Although the title page represents the book as being revised and enlarged from the first German edition of Dr. Nadai's book, and Mr. Wahl is set forth as being the translator, this book cannot be considered as a translation. Actually, the author of the German book, with the assistance of Mr. Wahl, wrote this book in English.

Both elastic and plastic deformation are covered thoroughly, including theories of strength and the distribution of stresses. Mathematical treatments are relatively few and simple, most of the text being an exposition of the action of bodies and crystals subjected to various types of loading, and the resulting plastic deformation or flow. Of particular interest are the "sand heap analogies" developed by the author.

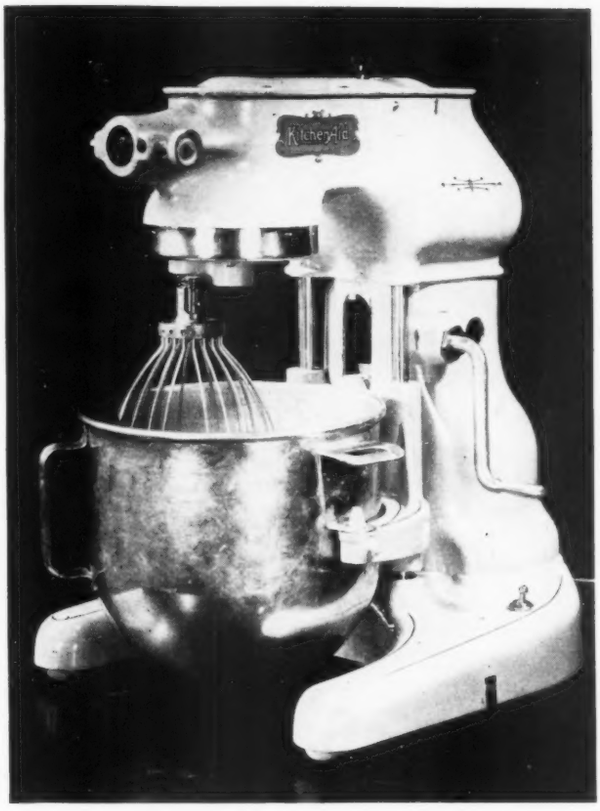
Much credit is due the authors for writing a book that presents a complex subject in a clear and simple manner. Not only does this book have immediate value for engineers dealing with stress calculations, but also for those dealing with processes involving plastic flow, such as rolling, forging and deep drawing.

TAMING OUR MACHINES. *The attainment of human values in a mechanized society. By Ralph E. Flanders. 244 pages, 5½x8½ in. Bound in cloth boards. Published by Richard R. Smith, Inc., New York. Price $2.50.*

THOSE of us who are devoting our lives to the study, creation and operation of machines will do well to pause occasionally in our efforts and take inventory of what we have accomplished, for good or ill, or what we are likely to accomplish if we continue along present lines, and of what the effect of our efforts on our civilization may be. Mr. Flanders' book represents such a pause on the part of one of the ablest of the engineers engaged in the design and construction of machine tools. He thinks as an engineer but, if the truth be told, it must be admitted that he expresses his thoughts far more lucidly than does the great majority of the profession.

In his concluding chapter Mr. Flanders goes back into human history and points out how five different cultures have flowered and decayed, showing much the same cycle of events. Our own culture has now reached a peak corresponding to the point in previous cycles where decay has begun to set in. Are we going to be able to avoid the fate of earlier cultures or must we, likewise, go down to ruin because of our inability to direct our destiny? The author is optimistic provided we make the most of certain current trends in economic, political and sociological thought. His reasons are well worth careful study, as is the whole book.

Trends in Product Engineering



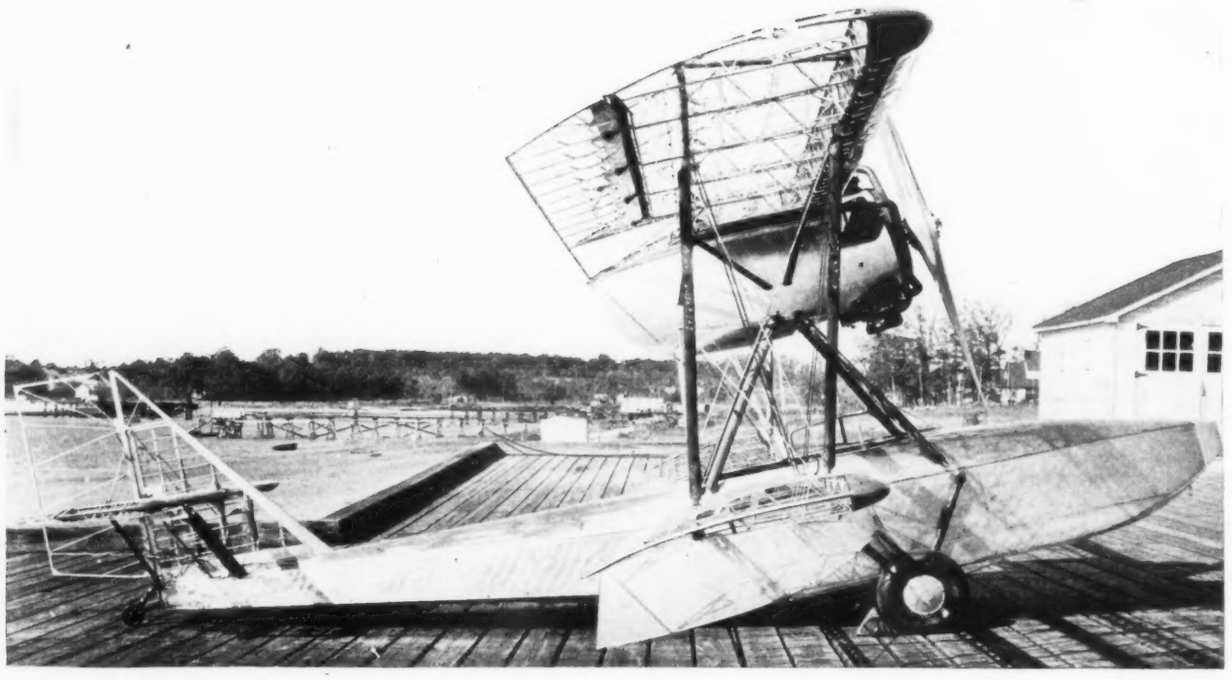
Labor-saving devices for home and hotel grow more popular

MECHANIZATION of food handling is the keynote of the moment visualized in the machinery displayed at the Sixteenth National Hotel Exposition at New York, the Dairy Industries Exposition at Atlantic City (see p. 550), and in a statistical survey by Ernst & Ernst which shows that householders paid $76,900,000 in 1929 for labor saving devices and $19,000,000 for oil burners alone for their homes. Illustrative of the adaptation of ideas proved successful by hotels for home use are a number of "cut down" hotel machines. The combination mixing bowl, beater, and whipper, illustrated above, has totally inclosed motor in the head and easily-cleaned surfaces. Another case in point is the electric muffin iron, a combination of a waffle iron idea with the doughnut-making machines used in bakeries. A casserole, designed by the National Enameling and Stamping Company, has a porcelain enamel pot and cover set into an outer body and surrounded on the sides by the two-heat heating units, outside of and beneath which is a layer of mineral wool insulation. The top fits into a groove in the turned flange of the pot, thus preventing escape of the cooking juices.

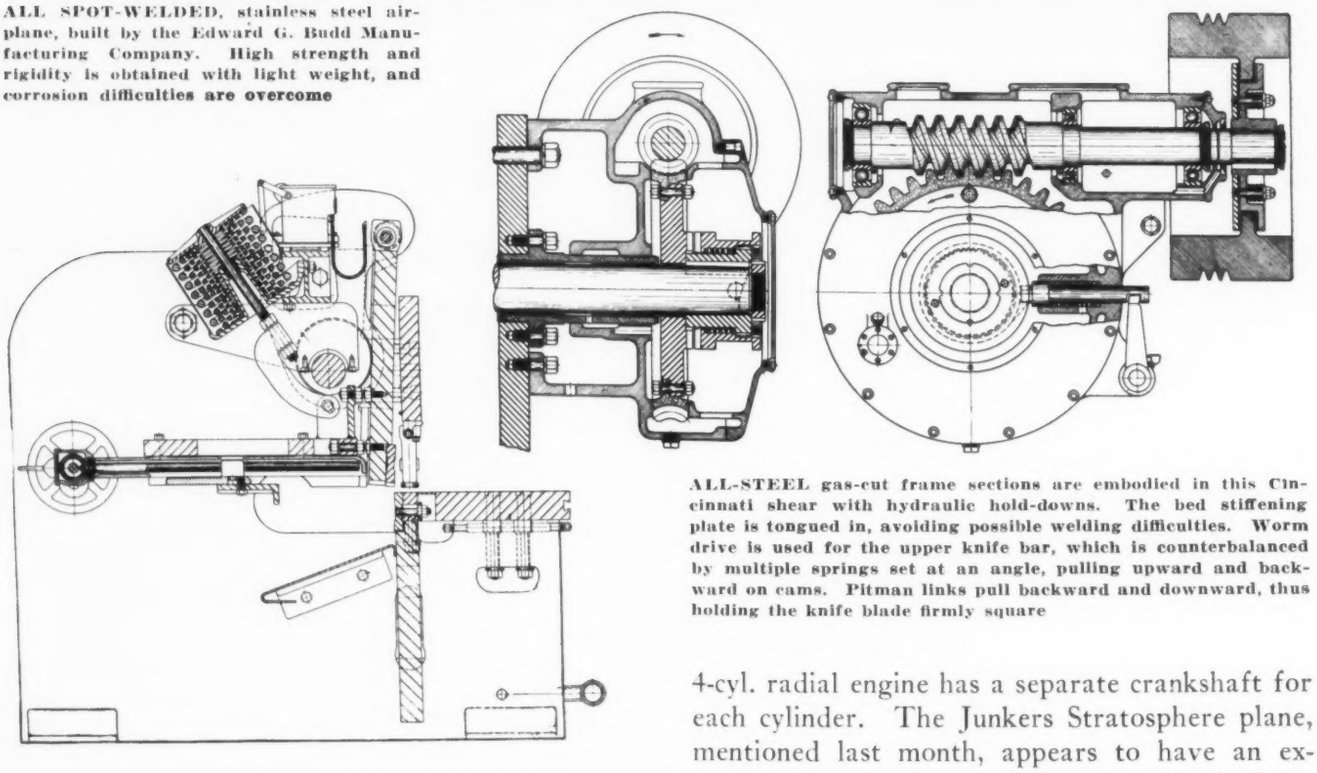
Illustrative of the diversification in product manufacture by electrical companies is a thermostatically controlled necktie-shaped pressing iron in aluminum with a Bakelite handle. It is slipped inside a tie to press it from the inside, thus preserving its surface. The electric clock made to retail for a dollar and mentioned in these columns last month, incorporates a molded Bakelite case and Durez self-oiling bearings. Hammond has produced a $4.75 kitchen clock in enameled metal and a $3.50 desk clock in Bakelite. This trend to a low price level is due to the simplicity of the induction disk motor and the low ultimate cost of molded cases and parts. Out of their experience with electric toys Lionel Corporation engineers have designed a wall-socket operated unit miniature apartment electric stove incorporating special switches to permit but two of the four 660-watt heating elements to be operated simultaneously. Several manufacturers, by utilizing new low material prices and clever developments in design have produced low-price washers that retain quality. The larger Leonard refrigerators include an automatic electric light which operates when the door is opened, rubber grid ice-cube trays, and a special egg basket.

Back to fundamentals, added accessories, on refrigerators

The new Potter refrigerator incorporates some of the good points of the older iceboxes in that the freezing unit is removed from the food compartment and placed in its own separately doored and insulated compartment. This provides three separate temperatures, 40 deg. moist cold for general food use, 40 deg. dry cold for frozen food storage, and 22 deg. in the freezing compartment. This is claimed to eliminate cold controls, special hydrating pans, defrosting, and the difficulties with sticking ice trays. The idea of "specialties" is expressed in the Kliegl program light for theater seats. The pressed metal cover plate sheds the



ALL SPOT-WELDED, stainless steel airplane, built by the Edward G. Budd Manufacturing Company. High strength and rigidity is obtained with light weight, and corrosion difficulties are overcome



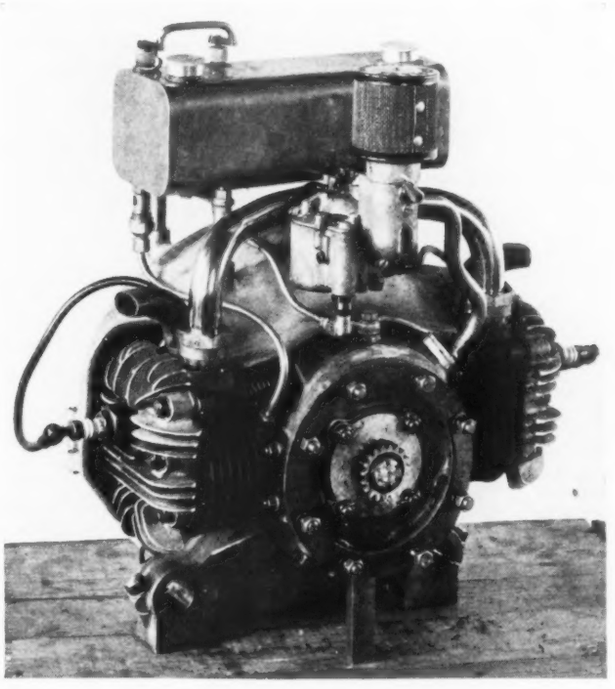
ALL-STEEL gas-cut frame sections are embodied in this Cincinnati shear with hydraulic hold-downs. The bed stiffening plate is tongued in, avoiding possible welding difficulties. Worm drive is used for the upper knife bar, which is counterbalanced by multiple springs set at an angle, pulling upward and backward on cams. Pitman links pull backward and downward, thus holding the knife blade firmly square

light only directly downward, and is flush with the seat to avoid catching of clothing. The bulb is battery operated to eliminate the necessity for extensive wiring. This unit is an example of "gadgets" designed for established services.

Higher speed planes, larger flying boats feature air progress

Diesel engine experiments continue in an effort to apply them to aircraft. The French Air Ministry is now testing a Clerget 7-cyl. radial Diesel rated at 350 hp. and weighing only 1.47 lb. per hp. The Universal 4-cyl. radial engine has a separate crankshaft for each cylinder. The Junkers Stratosphere plane, mentioned last month, appears to have an extremely long fuselage and sharply pointed wings. It will have a low speed at low altitudes, but is expected to make 500 kilometers per hour in rarer atmospheres. Its cabin is of all-metal construction, pressure regulated and oxygen supplied. That the German Do-X is not the ultimate in size is indicated by the announcement that the British Air Ministry is planning a flying boat twice its size, capable of carrying 120 passengers 2,500 miles at a speed of 120 m.p.h. Its engines will develop about 60,000 hp. and it will weigh about 60 tons loaded. Scouting planes for the "Akron"

go to the opposite extreme. These are to be small and light, may not have any landing gear except for a landing bar on top to permit it to be picked up and launched. The new Buhl autogiro will differ from previous ones in having a pusher type engine. This permits an outrigger tail instead of the fuselage required with tractor propellers, and allows reduction in weight.



Aircraft design practice has been applied to this compact, light-weight, 2-cyl. Reed-Prentice engine applied to agricultural machinery. Weighing but 46 lb., it produces 8 hp. at 3,600 r.p.m. The cylinder is nickel cast iron, the cylinder head and piston are aluminum alloy

Research may demand changes in design of electric street cars

Long-needed electric railway car research is at last coming. A number of testing devices have been developed for the work. One, embodying proportional weights and springs hung from a model car wheel eccentric, shows vibration characteristics of a car at various speeds. The elements are proportional to unsprung weight, journal springs, truck frames, bolster main spring, bolster auxiliary spring, and the car body. Attached to the back of a car and running over one rail and an auxiliary rail, another device records acceleration by means of a light bulb running beneath the railhead and a photo-electric cell above, the light affecting the cell periodically through slots in one side of the rail head.

In the station-type vertical drilling machine developed by the Automatic Machine Co., drive to all four boring spindles is by encircling V-belts driven by a jackshaft from the motor. As a pair of spindles comes back to the loading position, its driven sheaves leave the V-belt to stop spindle rotation. As the spindles leave the loading station, they again pick up the drive just before the first station, and are up to speed when they reach it. The same motor drives a vertical shaft reaching to the base, where by means of wormwheels and change gears drive is given to the entire spindle housing to rotate it at about 2½ r.p.m. The housing is carried on a tubular shaft surrounding the motor drive shaft. As the housing turns, it uncovers properly positioned ports in a circular coolant distributor.

Special magnets for road cleaning have been designed by the Ohio Electric Manufacturing Company. These units are rectangular, are suspended three from a truck, and save tires by gathering iron and steel from the road. The magnets are wound d.c. current and have impregnated asbestos insulation to prevent overheating on continuous runs or absorption of moisture when operating in the rain.

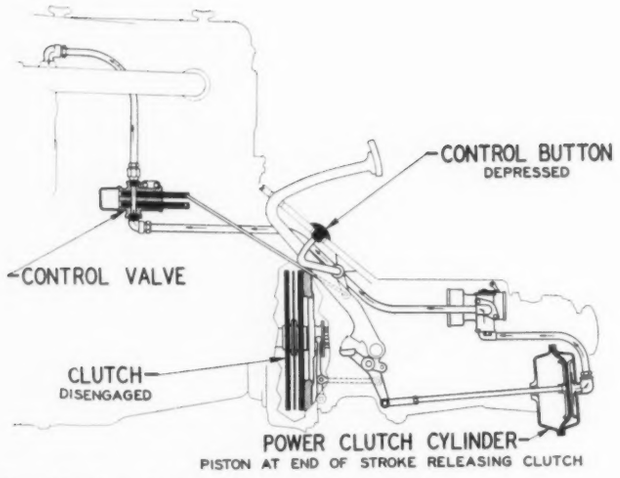
Radio costs go down, better models sell, consoles in demand

In the early summer, $45 midget radios were outselling consoles two to one. Now consoles are coming back, the average price having raised to $70. This permits radio engineers to offer more innovations in design. Dr. August Hand, meanwhile, has perfected a filamentless "cold tube" functioning on B-battery supply, which may reduce costs considerably, as this tiny tube is claimed to be as efficient as the standard tube. General Motors Radio engineers have produced a super-heterodyne converter which converts any tuned radio frequency model to make it highly selective and better in performance, and also acts as a remote control.

New talkie fields stimulate design
(See also p. 538)

Next in the "talkie" field will probably be stereoscopic movies. The problem is distribution of appropriate views to each eye of each observer, necessary to gain the proper stereoscopic effect. It entails provid-

Development of a mercury-arc, tungsten-filament bulb for the "sunshine lamp" brought about complete redesign of the lamp stands and shades. New table lamps of four makers are shown here. The fixtures, incorporating transformers in the bases, result in better lamps at less cost



Simplification of gear-shift operation through a Bendix vacuum-operated automatic clutch throwout is stressed in the new Buick. The automatic feature does not operate unless the button is depressed. Two of the five valves control engagement and disengagement, the three others control the "rate" of engagement

ing each spectator with proper spectacles and rearranging the system of projection to give higher speeds, great multiplicity of projectors, minutely ridged projecting screens, projection lenses of extraordinary defining power, and microscopic accuracy of film positioning. A possible step is the development of cameras which replace the shutter by a blinking neon bulb, the film moving continuously and projection being on a synchronized stroboscopic principle.

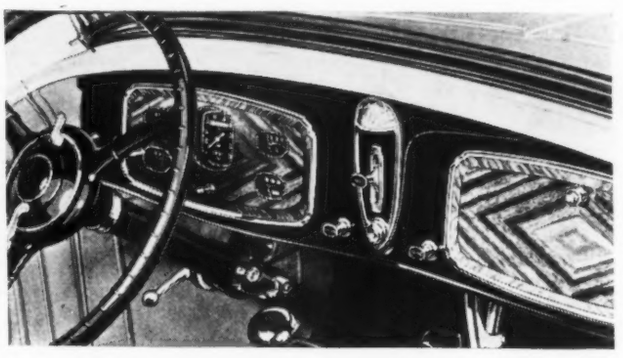
Road - maintenance units show some striking advances

Highway shoulder mowing has long been a "sticker." Various growths require different handling. Further, the mower should be a separable unit. The Toro mower just announced is composed of a power-driven sickle with the cutter bar attached to a steel frame which carries the motor. This is mounted on pneumatic-tired wheels in tandem, the unit being attached to any make or type of truck by a universal coupling and telescoping pipe. Guide chains at front and rear maintain alignment. Extreme flexibility is attained, the two-wheeled unit being operated at a variety of angles close to and distant from the truck, while the sickle bar can be adjusted to any angle from the truck itself by a drum and cable. It cuts an average of 40 to 50 miles of roadway a day. An emery wheel on the motor provides sharpening means.

A semi-automatic dipper trip for power excavators has been announced to supplant hand tripping. The device consists of a continuously running shaft driven by one of the shovel gears, upon which is mounted two friction disks and a drum. The smaller disk, spring actuated, maintains a tight trip line, while the larger, capable of exerting a pull up to 400 lb., is used to trip the bucket latch. Control of the latter element is through one of the regular operating levers fitted with a hinged handle.

Automobile changes mostly refinements, European trends

New automobile models to be announced shortly bear out the prediction (PE—Page 489, Vol. 2) that only refinements would be incorporated. The "Wizard" clutch control and rearranged instrument board of the Buick are cases in point. Since American body design partially follows European trends, certain developments indicated at the recent British Olympia passenger car show may be of interest. The trend there is to offer the greatest possible seating capacity with the smallest possible engine to meet the demand to save tax, insurance and operating cost. Twelve of fifteen new models are 14 hp. or smaller, none of them with more than six cylinders. An "in-between" type was prominent, having a wheelbase of about 90 in., consequently larger than the midget type but smaller than standard models. Cars of this type are leading the market there, and sell for a

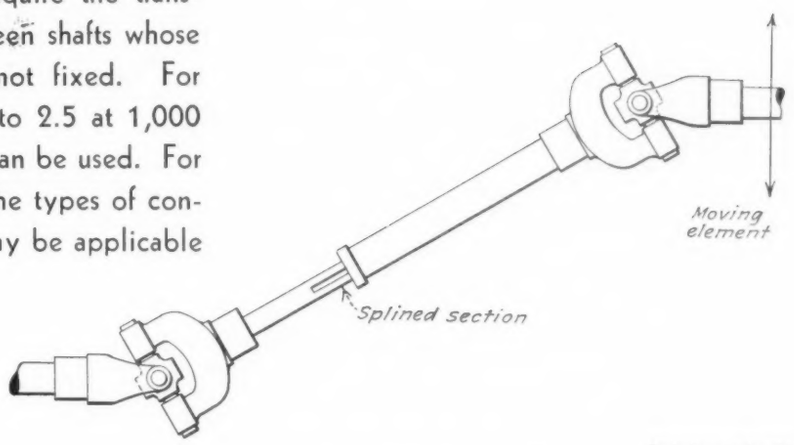


Instrument concentration in one left-hand panel visible through the 3-spoke steering wheel is one of 18 refinements in the new Buick which is indicative of the refinement trend in all 1932 models

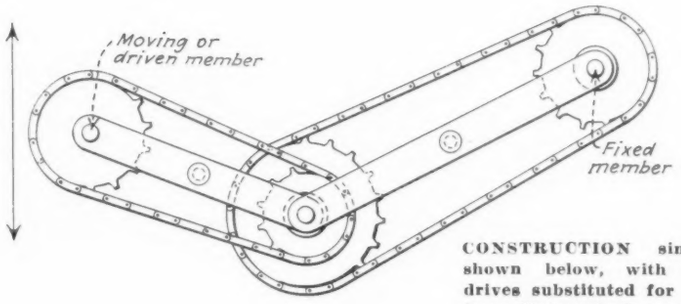
bit more than the midget. Fabric bodies, popular several years ago, are very rare, most makers preferring composite bodies. Most bodies extend the rear end paneling to cover the fuel tank, a small luggage locker being put over the tank. One of these types permits the rear section to be swung down to form a gridded luggage carrier, but avoiding the undesirable appearance of the carrier when not in use. Also, many cars are provided with the sliding roof demanded by four out of five British buyers. Windshields have a pronounced forward slope, doors following this sloped line to the foot. One maker shows a hinged signalling window which swings back as the hand is withdrawn to permit the window to be raised or lowered as a unit.

Mechanical Transmission Between Moving Elements

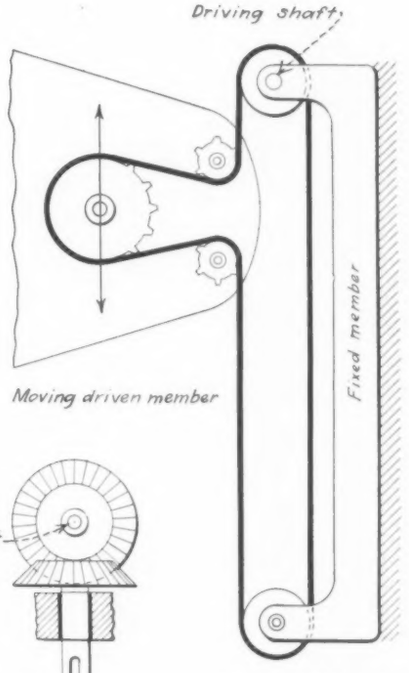
Certain constructions require the transmission of power between shafts whose relative positions are not fixed. For small horsepowers, up to 2.5 at 1,000 r.p.m., flexible cables can be used. For larger powers, one of the types of construction shown here may be applicable

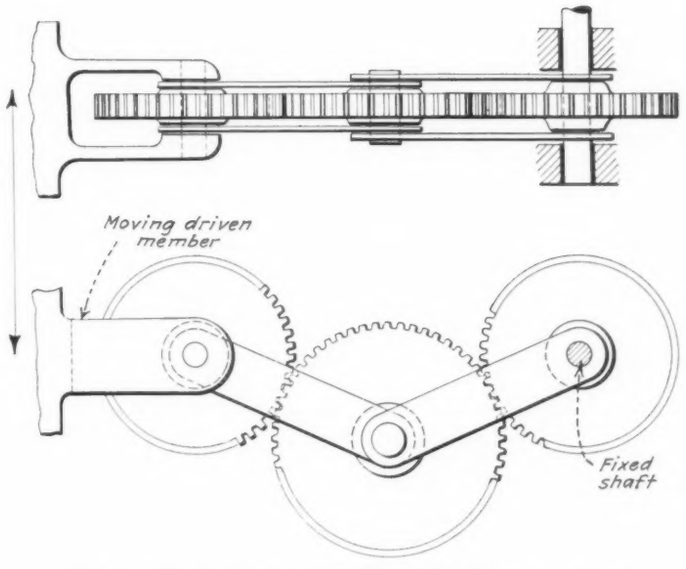


UNIVERSAL joints can be used only when the angle between the shafts does not exceed about 15 deg. For uniform transmission, universal joints must be used in pairs

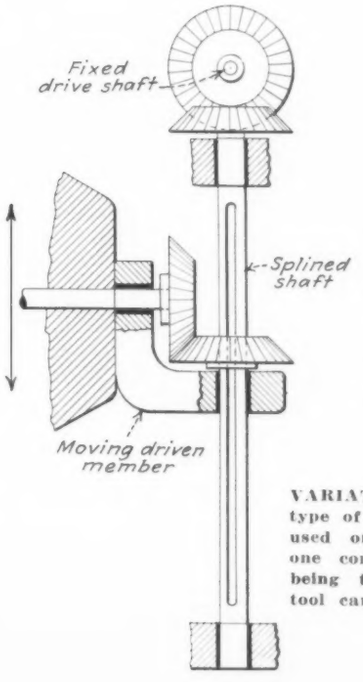


CONSTRUCTION similar to that shown below, with chain or belt drives substituted for gears. The intermediate wheels are either in one piece or keyed together. Use of chains or belts permits a greater range of action





ONE END of each of the two links is pivoted on the driving shaft and driven shaft respectively, and the two links swivel on the pin that also serves as the shaft for the intermediate gear



IN ORDER that there be no change in belt or chain length required, the pitch circles of the driving wheel and the three idlers must all be tangent to the same straight line

VARIATIONS of this type of transmission are used on machine tools, one common application being the drive to the tool carriage on a lathe

A New Industry Out of A

Circulating libraries of educational - amusement talkie films are being visualized for every town. Combination of 12-in. 15-min. records synchronized with 16-mm. projectors make a low-priced unit practical. Here is how one company redesigned for this field

TWO methods of getting synchronized sound with pictures have been developed for theatrical talkies. One has the sound recorded on a disk record, the other on a sound track on the side of the film.

For 16-mm. work, the sound-on-disk method was selected for several reasons. In the first place, the photo-electric cell required in the sound-on-film method is delicate and calls for technical skill in use, besides being an unfamiliar device. These are decided drawbacks in the home entertainment and sales fields. Secondly, there are technical difficulties of getting the proper speed for the sound track on 16-mm. film. The slowest linear speed used for sound reproduction in the professional field is 90 ft. per min. With commercial 35-mm. film having 16 frames per foot, this means that 24 frames pass the aperture per second. With 16-mm. film having 40 frames per foot, 60 frames per second is the required speed. It will be obvious, when the cycle is analyzed in the accompanying illustration, that the problem of 16-mm. sound-on-film involves great difficulties.

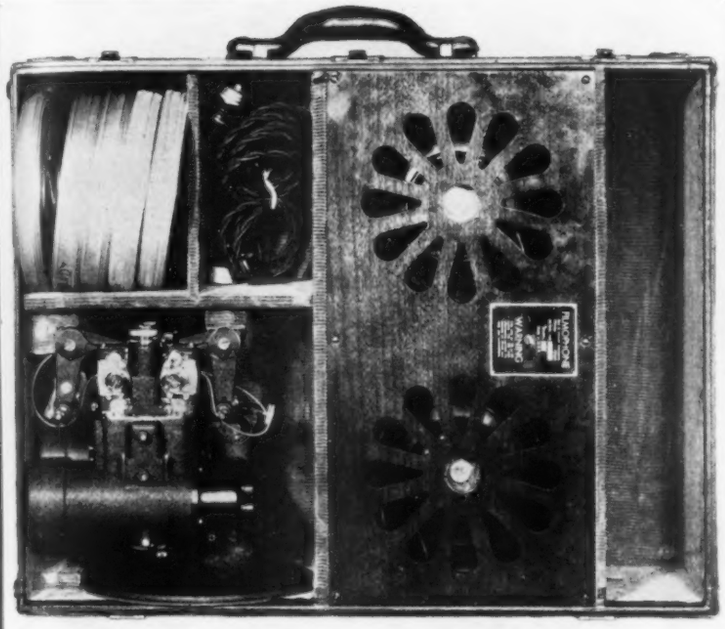
Hence we decided to devote our efforts toward the disk record method of reproduction, introducing the new conception of a talking movie in the home on the basis of the familiar use of the phonograph. The speed of projection is confined to 24 frames per second. This involved speeding up the former silent Filmo 16-mm. projector, operating at 16 frames a second, and driving the record turntable in synchronization with it. As first conceived, the idea was to have separate driving motors for each unit and to keep them in step by a balancing shaft made up as a flexible cable or an equivalent arrangement. But since the projector driving motor had to be modified to provide for the 50 per cent increase in speed and corresponding amount in power, it was decided to revamp it completely and supply a motor of sufficient power to operate both the projector and the turntable at the very close limits of speed necessitated by talkie work.

Referring to the projector proper, a 50 per cent increase in speed would require that much greater power, but the loads would remain approximately the same. No change would be necessary, therefore, in any of the film and shutter actuating mechanism. In the standard Filmo projector, the main drive has an extension in front with a knurled portion for turning the mechanism by hand when threading the film and also for rewinding by power through an auxiliary spring belt. By slight modification this extension serves for a power take-off device for the turntable drive through a flexible shaft.

Like the old one, the new motor stator and rotor are purchased units. Although exact speed regulation is essential for faithful sound reproduction, the series-wound universal motor is satisfactory in this application because the load is uniform. In the talkie model an additional load is present—the friction of table drive and the slight

# of An Old Product

By R. FAWN MITCHELL
Manager Technical Service, Bell & Howell Company



braking effect of the needle—but these loads are uniform also. Speed regulation in both the old and new models is obtained by a brake, and the motor is so powered that even with the lowest operatable voltage, some braking is required. The brake is simple in form and shows little wear over long periods. It consists of a segmental wood block floating in a recess in the end frame of the motor and backed by a spring plunger adjusted from the outside. Braking action is against a steel disk riveted to the web of the fan rotor.

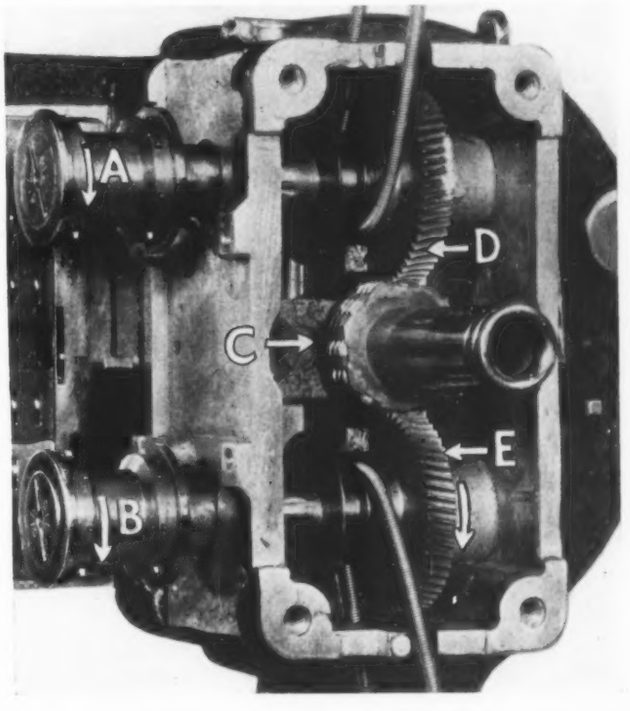
In the silent 16-mm. projector, speed was comparatively unimportant and was gaged by three factors: normal action in the projected picture, freedom from flicker, and sometimes by the hum of the motor. Once sound is introduced, variations in speed are important, as the average person is sensitive to a change in pitch of 0.5 per cent. Hence, a simple form of stroboscope has been added to determine and maintain a record speed of 33-1/3 r.p.m., which is standard for 16-in. commercial talkie records. The periphery of the turntable extends below the center portion; in this flange portion are drilled a series of holes, 108 in the top row and 90 in the bottom row. A neon lamp is mounted underneath the turntable and can be seen through these holes. When operated on a 60-cycle supply, the top row of holes appears stationary when the speed is exactly 33-1/3 r.p.m. Similarly, the bottom row appears stationary at that speed on a 50-cycle supply. This stroboscopic speed indicator is simple, yet accurate, and never needs attention.

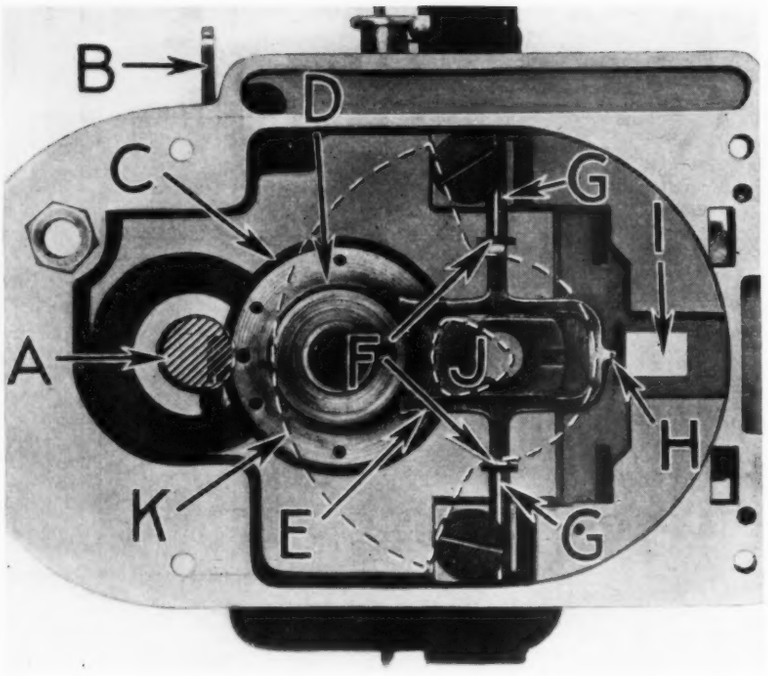
The turntable is an aluminum sand casting spoked in the center for lightness, and carefully turned and balanced. Drive from the flexible shaft is by a steel worm and Formica wormwheel, both mounted in bronze bearings and packed in grease. Smooth and silent operation is assured by precision-cut teeth and correct alignment. Like the projector itself, a black crystaline lacquer is applied to the worm gear case, which is likewise diecast aluminum.

In the same traveling case that contains the turntable are the audio-frequency amplifiers for the loud speaker, set in a separate unit. Both the electrical pick-up and the amplifier are standard units, as is the loud speaker. Standard a.c. radio tubes are used and hence are readily replaceable.

In designing the case for the speaker unit, the size was selected in conformance with proper

Sprockets *A* and *B* for feeding the film must rotate in the same direction. They are driven by helical gears *D* and *E* which have right- and left-hand helixes. The common driving pinion has right- and left-hand helixes superimposed





Operation of Framing Mechanism

Positive movement of film, without the necessity of a framing device, is attained by a tooth *H* that engages the perforations on one side of film. Projector motor drives main gear *C* from a helical pinion at *A*, controlled through clutch *B*. The main gear shaft also drives the flexible shaft to the record turntable and the film sprockets. Cylindrical cam *D* on same shaft, and integral with the hub of gear *C* is shaped to impart to shuttle *E* an oscillating motion about a vertical axis. At the same time *E* is also given an up-and-down motion by heart-shaped cam *J*, driven by a helical pinion from gear *C*. The shuttle member rotates about and slides on fixed pins *G*. Shutter *K* is fixed on the same shaft as cam *J* and rotates with it, at three times the speed of main gear. Every third revolution, when shuttle is in its topmost position, cam *D* guides tooth *H* into the film perforation, holds it there during the down stroke, and then retracts it. During this shifting the shutter excludes light from the aperture *I*. The entire cycle for one frame is 1/24 sec. and for the shift 0.005 sec., but engagement is so positive that no undue strain is put on the film

baffling and to provide space for the folded projector. As the electrical pick-up is placed at one end of the hall and the speaker at the other, adjacent to the screen, two cases are necessitated. Division of the bulk and weight is another consideration. These two carrying cases are designed to resemble "suit cases" as much as possible, the fiber board being faced with imitation leather. The sound is emitted through a wood grill with cloth screen, covered with a slide when in transit.

At the time the projector was being adapted for talkie work, a change was also made in the lighting unit to extend the range of the machine to fair size auditoriums. The former 50-volt lamp has been replaced by a 75-volt, 375-watt lamp, giving 41 per cent more light and making possible a 16-ft. image at 150 ft. The lamps are designed especially for this type of service, because the small frame size necessitates an extremely concentrated filament. A brass ring with centering prong is soldered to the base to maintain the plane of the filament coils perpendicular to the optical path and set them at the proper height.

Most of the lamp wattage is dissipated in the form of heat. Cooling is provided by the motor fan. The greater energy dissipated in the new lamp is offset by more cooling air owing to speeding up the motor. Emission of light through cooling ports in the top is kept down by placing a metal shield over the tubular lamp.

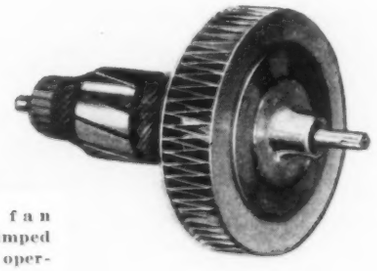
Exact voltage control is essential and some means must be available for reducing the 115-volt supply. On the 50-volt lamp, a tapped rheostat is used, consuming over 300 watts. A transformer was out of the question because of the possibility of d.c. operation, aside from considerations of added bulk and weight. With the 75-volt lamp, although the total wattage remains the same, the rheostat loss drops to 200 watts, so that less resistance is necessary. As the motor draws only $\frac{1}{2}$ amp., total current drawn from the line is practically the same for either model.

By locating this rheostat on top of the lamp house, the factors of appearance and adequate cooling are solved. Its contour blends with the housing below and the porcelain body is finished in the same black crystaline lacquer. Incidentally, it took four years of development work on the part of our supplier to perfect a porcelain that would resist the rapid fluctuations in temperature encountered, as well as mechanical shock in handling.

Shutter construction and the means for presenting, holding and withdrawing 24 frames a second are explained in the illustration. The only work the shuttle finger has to perform is to move a fraction of an inch of film past the aperture and accurately register the frame at the aperture. Positive feed and removal of film are assured by toothed sprockets, and in addition both winding and unwinding reels are power driven by small spring belts from pulleys on the sprocket shafts. Hence, the film is propelled at five points so that the load at any one point is small and danger of film breakage reduced. To compensate for the

intermittent motion at the aperture, the film is looped above and below to allow it to "breathe." While passing through the film channel, side sway is prevented by registering the film against one edge by spring pressure, and to offset any buckling action in the center there are several sets of tiny hardened steel guide rollers on needle shafts sunk into facing guide members. They are set just below the film and above the countersunk center portion of the aperture plate.

Each sprocket is made of brass, nickel plated, and has an idler roller on either side to hold the film in 180-deg. contact. A screw plug in the face of the sprocket covers a wick for lubricating the bearings from which the sprocket is overhung. Each hollow sprocket shaft is split in the middle for assembly reasons and is driven at right angles from the same gear on the main shaft. Since both sprockets must rotate in the same direction, a peculiar form of gear has been developed. The two driven gears are sharp-pitch helical gears, while the common driving pinion is a cross between a worm and a helical gear with two sets of threads, right and left hand. The unusual shape of the teeth has suggested the name "diamond" as best describing this special form. Both pinion and gears are cut from steel.



MULTI-BLADE fan made from crimped aluminum ribbon operates quietly and equally well in either direction. Integral with the hub flange is the brake disk for speed control

All parts of the shuttle mechanism are of hardened steel, ground within close limits at the contacting areas. Integral shoulders on the mainshaft and camshaft form raceways of tiny cup and cone ball bearings. The shuttle itself slides on two polished steel pins which are held in milled slots by large flathead screws. Fits specified for mating members are especially close, necessitating selective assembly practically throughout.

Lubrication is always a problem in a portable machine. Aside from the sprocket hubs mentioned, there are five places where oil can be applied: through a snap cover oiler and two-spring-ball oil holes in the top of the projector body, and two oilers at the reel-bearings. The main oiler conducts oil by felt wick to the shuttle mechanism, and the two ball oilers supply the main shaft and the camshaft. A sufficient quantity of grease is supplied the turntable worm and wheel to last the life of the unit, and the motor ball bearings are similarly packed in grease.

Standards of quality and workmanship equal those of professional projectors. Owing to the rigid requirements of sound projection, the results are either right or worthless. Hence, performance, rather than price has been the governing factor in the choice of materials and mechanism. While it is the highest priced instrument of its type, its inherent quality has resulted in gratifying sales which, after all, are the best gage of engineering and manufacturing policy.

Revise the College Courses

By John H. Talbot

ONE recent editorial opines that college engineering courses be lengthened to five years "for those men who really aspire to a professional standing," while a three-year course "stressing the fundamental sciences, business administration, and the humanities," be evolved to "satisfy the social demands for a college education." Another editorial in another publication suggests that every individual be forced to attend college, on the theory that no matter how little the individual may learn or how crowded classes may be, everyone should at least learn something.

To begin with, no student attends an engineering college to "satisfy the social demands for a college education." Social demands are met by an arts or science degree, much more easily attained than an engineering degree. Again, industry finds it necessary to give the engineering graduate from one to three years of practical training after graduation before he is considered to be worth much to his employer. Why not incorporate some of this practical training as a requirement for a degree, making it essential that the candidate have a given amount of practical experience? In this way he will be sufficiently matured to make a sensible decision regarding his future life work. Again, why continue the present system of grading and examination, which is certain to end up as a battle of wits between a student who finds it "clever" to beat the game and an instructor who becomes a watchdog? Why not rather give one final examination after the conclusion of the college course?

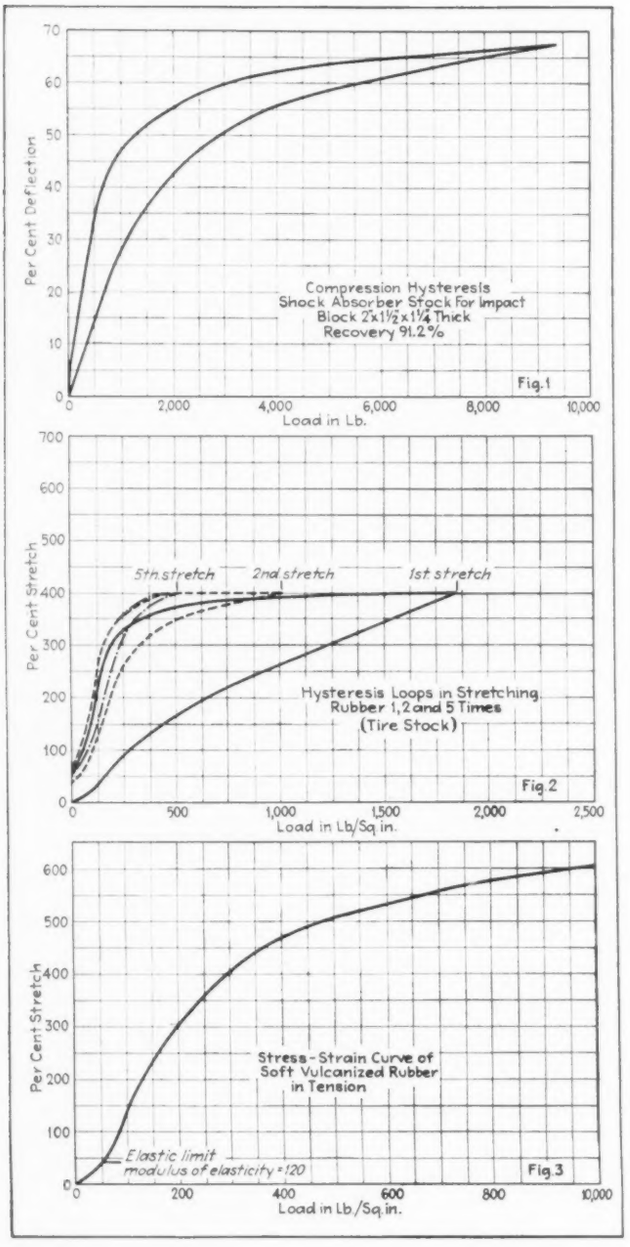


Fig. 1—Expenditure of energy in molecular friction, ordinarily termed hysteresis, is shown by the hysteresis loop in one complete compression cycle of a block of soft vulcanized rubber

Fig. 2—With constantly repeated cycles and a constant vibrating force, the hysteresis loop areas become almost constant. But for a vibrating force of varying magnitude the loop areas vary and afford a source of variable friction, which is desirable in most instances. The areas of these loops may be varied within wide limits by the recipe or compound of rubber used. Highly pigmented stocks have large hysteresis losses, while stocks approximating pure gum have relatively small losses. Low hysteresis loss is most desirable for cushioning shocks and damping vibrations

Fig. 3—A study of the magnified stress-strain curve discloses that rubber does not behave according to Hooke's Law except at very low elongations. Stress is proportional to the strain up to about 50 lb. per sq.in. Within this limit, high-grade soft vulcanized rubber will be almost perfectly elastic under repeated reversals of stress. Computations show this particular stock to have a modulus of elasticity of 120, compared with steel whose modulus of elasticity is approximately 30,000,000. For shock absorbing, rubber of a very low modulus is used.

Isolating Vibrations with Rubber

By F. L. HAUSHALTER
Engineer, The B. F. Goodrich Company

ISOLATION of vibration, vibration damping, noise reduction, and shock absorption through the medium of rubber have been brought forcibly to the attention of engineers during the past months by numerous notable developments. The Chicago Rapid Transit Company is now testing rubber pads under the tieplates to reduce noise and vibration, incidentally reducing tie replacement formerly necessitated by the steel tieplates wearing into the wooden ties. One of the leading railroad companies has applied rubber to railroad car trucks and under the platforms of coaches, to relieve wear and reduce noise. Motor suspension on rubber mountings and insulation of motor from the chassis by rubber pads or bushings have this year become "standard" construction on many passenger automobiles.

Application of rubber mountings for vibration isolation has been made possible by the advances in the science of rubber compounding which have made available grades of rubber that will stand up over a period of years with little deterioration or change in physical properties. Formerly, some authorities maintained that pads of organic materials such as rubber or cork were usually too stiff to reduce the effect of the principal harmonics of the impressed force, and were useful only in absorbing vibration due to higher harmonics. Similarly, in the past, the properties of these materials changed with time, for which reason steel-spring shock absorbers were considered to be the only suitable type. These objections no longer hold. Using highly age-resisting rubber compounds, engineers have developed shear and tor-

Why shear type mountings? How should compression pads be designed? How does the amount of energy absorbed vary with thickness? What ranges of temperature can rubber withstand? These questions are answered authoritatively in this article by an engineer who has participated in many rubber-mounting developments

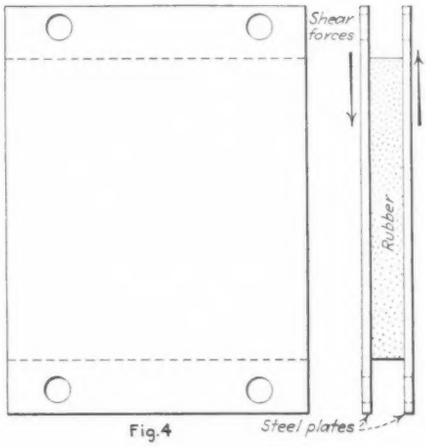


Fig. 4—In typical shear type mounting, the rubber is bonded to two metal plates, one of which is fastened to the vibrating member and the other to the support or foundation

sion type mountings that have the characteristics of steel springs. In addition, these rubber mountings have a great advantage over the spring type in that they are of much more stable construction.

Perhaps the outstanding property of rubber that is bringing it into broad use as a shock absorber in the automotive and industrial fields, is that of plastic friction within the mass of the material, making possible elastic-plastic deformation. Rubber is not perfectly elastic because of energy dissipated by internal friction of the rubber and pigment molecules of which it is made. In rubber mountings, the internal friction of the rubber tends to dampen out the fundamental period of the mounting, an advantage that springs do not possess.

Expenditure of energy in molecular friction is ordinarily termed hysteresis. In Fig. 1 is shown the hysteresis loop in one complete compression cycle of a block of soft vulcanized rubber 2x1½x 1¼ in., used to isolate the bases of machines against vibration. In Fig. 2 are shown similar loops for complete cycles when stretching rubber one, two and five times.

Inherent capacity to store a great deal of work,

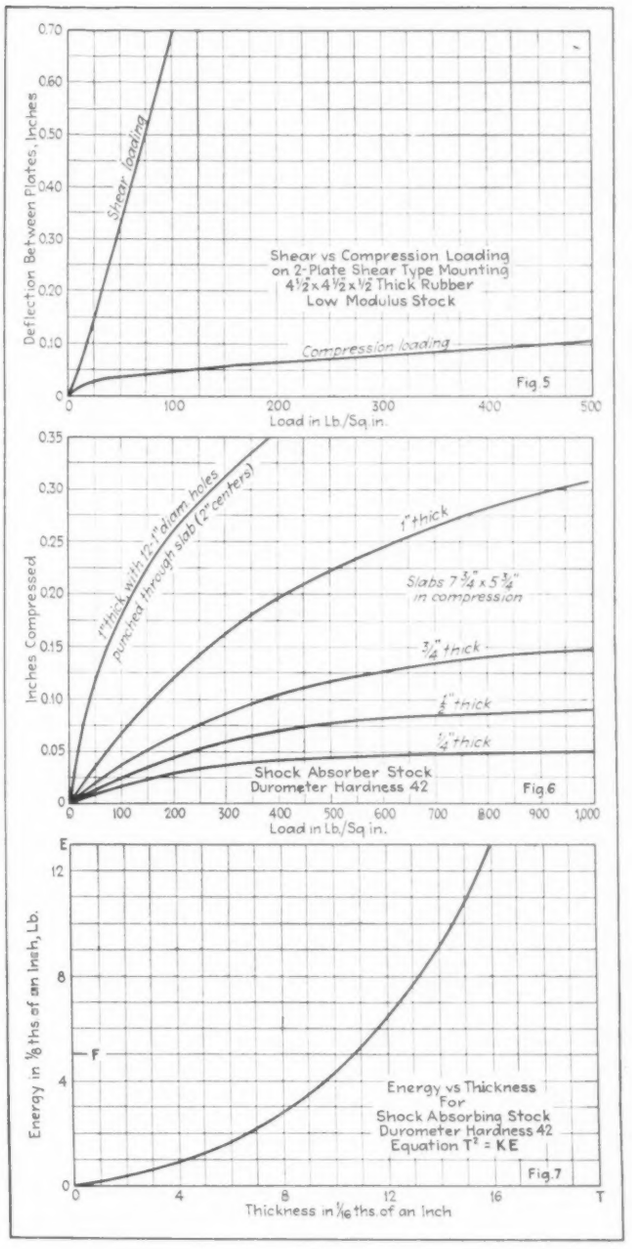

Deflection Between Plates, Inches
Shear loading
Compression loading
Shear vs Compression Loading on 2-Plate Shear Type Mounting 4½x4½x½ Thick Rubber Low Modulus Stock
Fig. 5
Load in Lb./Sq. in.
Inches Compressed
1" thick with 12-1" diam. holes punched through slab (2" centers)
1" thick
Slabs 7¾"x5¾" in compression
¾" thick
½" thick
¼" thick
Shock Absorber Stock Durometer Hardness 42
Fig. 6
Load in Lb./Sq. in.
Energy in 1/8 ths of an Inch, Lb.
E
F
Energy vs Thickness For Shock Absorbing Stock Durometer Hardness 42 Equation T² = KE
Fig. 7
Thickness in 1/16 ths of an Inch
T

Fig. 5—For a given load, spear type mountings permit about 8½ times as much movement as would be obtained with compression mountings

Fig. 6—The area under the curves represents the work required to deform the rubber pad in compression. The greatest deformation is that of the 1-in. thick slab with 12 1-in. dia. holes punched through it

Fig. 7—If thickness be plotted against work done on the rubber, a parabolic curve is obtained, indicating that the benefit derived from rubber in absorbing movements is proportional to the square of the thickness

as shown by the load-compression curves in Figs. 1 and 2, is another characteristic of rubber. The modulus of resilience is defined as the in.-lb. of work per cu.in. of mass in deforming the material within the elastic limit. Test pieces of rubber and steel, each 2x¼x⅛ in. thick, stretched to a point where further loading would result in permanent deformation of the steel or failure of the rubber,

have comparative stored energy values of 6.6 in.-lb. for the steel as against 322 in.-lb. for the rubber. This high energy capacity combined with the property of internal friction or hysteresis loss makes rubber an exceptional material for dissipation of vibration energy. This is especially true because rubber compounds can now be manufactured with very low permanent set. One particular rubber compound, used in the spring shackles of automobiles, has a permanent set of only 3 per cent when compressed 60 per cent of its original height of 1 in. between flat steel plates and subjected to a temperature of 160 deg. F. for 48 hours.

Rubber is much more sensitive to distortion by a specified load when in shear or tension than when in compression. In Fig. 4 is shown a typical shear type mounting in which rubber is bonded to two metal plates. Used in a vertical position, one plate is fastened to the vibrating member and the other to the support or foundation. One manufacturer of vibrating screens uses a mounting of this type at each of the four corners of the machine. The screen is allowed to vibrate, which it must do to work efficiently, but very little of the vibration is transmitted to the screen foundation. In Fig. 5 are illustrated the relative characteristics of a support of the type shown in Fig. 4 when in compression and in vertical shear. It is seen that under a load of 1,000 lb. the relative plate movement in compression is less than 0.04 in., as against a movement of 0.33 in. in the shear position. Thus, in shear the movement under a given load is about $8\frac{1}{4}$ times that of the movement under compression.

For use under the foundations of heavy machinery, pads of soft vulcanized rubber readily lend themselves to the absorption of vibration. The accompanying curve, Fig. 7, shows the relation between the thickness of rubber pad and the amount of energy absorbed. This curve closely follows the general equation:

$$T^2 = KE$$

In this equation T represents the thickness of rubber in sixteenths of an inch, and E is expressed in eighths of an in.-lb. of work. The value of the constant K depends upon the stiffness of the rubber used. For shock absorbing rubber, such as used for the absorption of vibrations under bases of machines, K will have a value of about 19.6 in the above equation.

Instead of using solid slabs of rubber to cover the entire foundation under a machine, it is most beneficial to have the rubber cut into strips or perforated with holes. Rubber in itself is as incom-

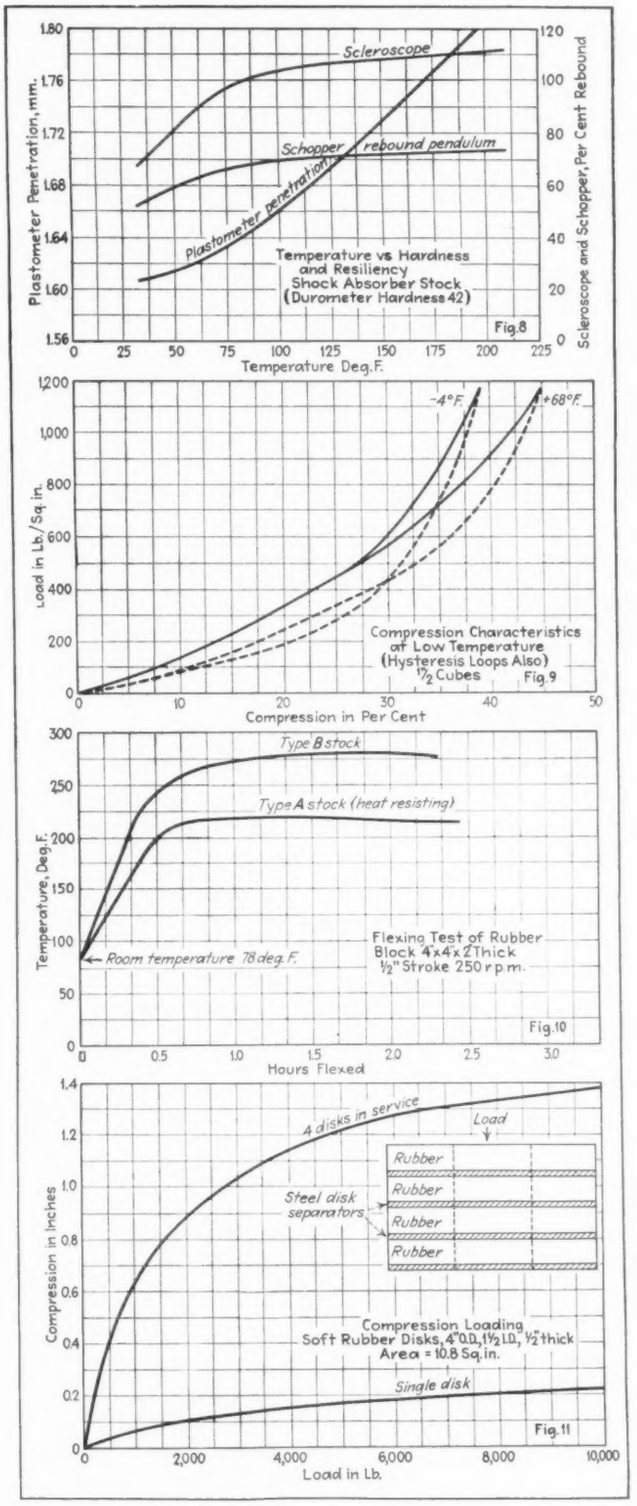

Plastometer Penetration, mm.
Scleroscope and Schopper, Per Cent Rebound
Scleroscope
Schopper rebound pendulum
Plastometer penetration
Temperature vs Hardness and Resiliency Shock Absorber Stock (Durometer Hardness 42)
Fig. 8
Temperature Deg. F.
Load in Lb./Sq. in.
-4° F.
+68° F.
Compression Characteristics at Low Temperature (Hysteresis Loops Also) 1/2 Cubes
Fig. 9
Compression in Per Cent
Temperature, Deg. F.
Type B stock
Type A stock (heat resisting)
Room temperature 78 deg. F.
Flexing Test of Rubber Block 4x4x2 Thick 1/2" Stroke 250 r.p.m.
Fig. 10
Hours Flexed
Compression in Inches
4 disks in service
Load
Rubber
Steel disk separators
Compression Loading Soft Rubber Disks, 4" O.D., 1 1/2 I.D., 1/2" thick Area = 10.8 Sq. in.
Single disk
Fig. 11
Load in Lb.

Fig. 8—In the range between ordinary room temperature and 200 deg. F., the effect of the temperature on the resiliency of the rubber is small

Fig. 9—Compression characteristics of rubber are but slightly affected in the temperature range from —4 deg. F. to + 68 deg. F.

Fig. 10—Proper compounding of the rubber will greatly increase conductivity, making it capable of withstanding rapid flexures of considerable amplitude

Fig. 11—Multiple disks of rubber with steel plate separators can be used in series to take care of a given desired amplitude, the proper compound of rubber being chosen to take care of the load requirements

pressible as water, so it is very necessary to provide recesses into which the material can flow. Otherwise, undue pressures are built up under load. Of course, unless the rubber has some place to flow, it cannot absorb any movement. The curve shown in Fig. 6 illustrates the effect of perforating the slab.

For most installations it is usually best to work rubber compression slabs under pressures of less than 50 lb. per sq.in. and rubber-to-metal shear type mountings under about 20 lb. per sq.in. of effective shear area. At these values the rubber is being worked on the steep slope of the deformation curve and will, therefore, be most sensitive to impressed vibrational forces or torque reactions produced by changes in engine speed.

As for effects of temperature on the resiliency of rubber, from ordinary room temperature up to 200 deg. F., the resiliency is but little affected, as shown by the graphs in Fig. 8. The static load-compression curves in Fig. 9 also indicate that the percentage change in compression loadings resulting from temperature changes is very small. Experimental work on rubber motor mountings in the cold rooms of some of the automotive manufacturers has shown that although

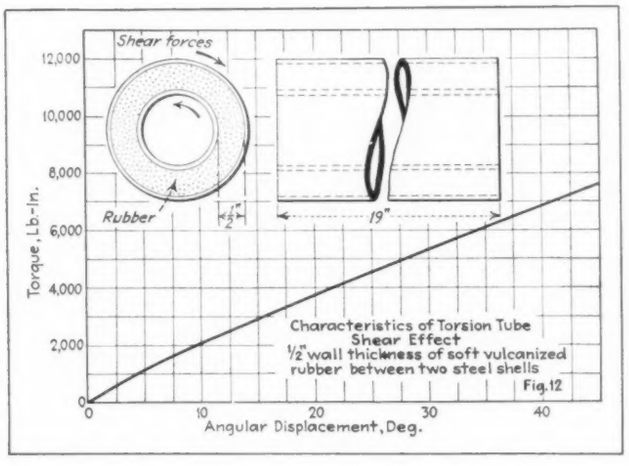


Fig. 12—Relation between the lb.-in. of torque and angular displacement of a torsion bushing having the wall of live rubber bonded to both inner and outer metal tube. Torque is almost directly proportional to the angle, incorporating in this respect, the characteristics of a spring

there is some change in the plastic flow of the rubber at temperatures around zero Fahrenheit, the change is not enough materially to affect the vibration absorbing efficiency of the mounting.

For absorption of shocks, rubber disks or slabs built up and separated by steel plates are much preferred to one solid cylinder or block of rubber. In a mass of rubber of considerable thickness, severe impact will set up a high amplitude of movement, the frequent repetition of which tends to build up temperature through internal working. Thus, overheating may cause the rubber to fail. The problem of dissipation of heat under these conditions requires a proper absorber and use of the correct compound of rubber. In the Spencer-Moulton draft gear, used widely in England, a series of concentric rubber rings about 8 in. in diameter absorbs impact forces of the order of 200,000 lb., momentarily resulting in enormously high unit pressures on the rubber. But under blows of this order delivered 200 times per min., the rubber would soon fail under the heat generated.

The specific heat of pure gum rubber is about 0.5 calories per gram per deg. C. and the heat conductivity about 0.00032 calories per degree temperature difference per cu.cm. per second. As shown by Fig. 10, the conductivity can be considerably increased by compounding such pigments as zinc oxide with the rubber. It is evident that for rubber subjected to repeated impact, a high rate of heat conductivity is desirable in order that the heat generated by severe repeated shock can be conducted more readily to the outer surface.

The limit to the possibilities of rubber for service as absorbers of severe repeated shocks must usually be found by experimental test work on specially designed laboratory flexing and impact machines where temperatures can be measured accurately by the insertion of thermocouples into the mass of rubber.

Coupled with the foregoing advantages, rubber can be molded into almost any shape during the process of vulcanization, and can be adhered to metals with bonding strength as high as 600 lb. per sq.in. This makes possible almost unlimited variations in developing rubber and rubber-to-metal mountings for bases of machines, electric and internal combustion motors, generators, vibrating screens and reciprocating mechanisms, as well as for employing rubber in torsional dampeners for crankshafts and other types of revolving masses.

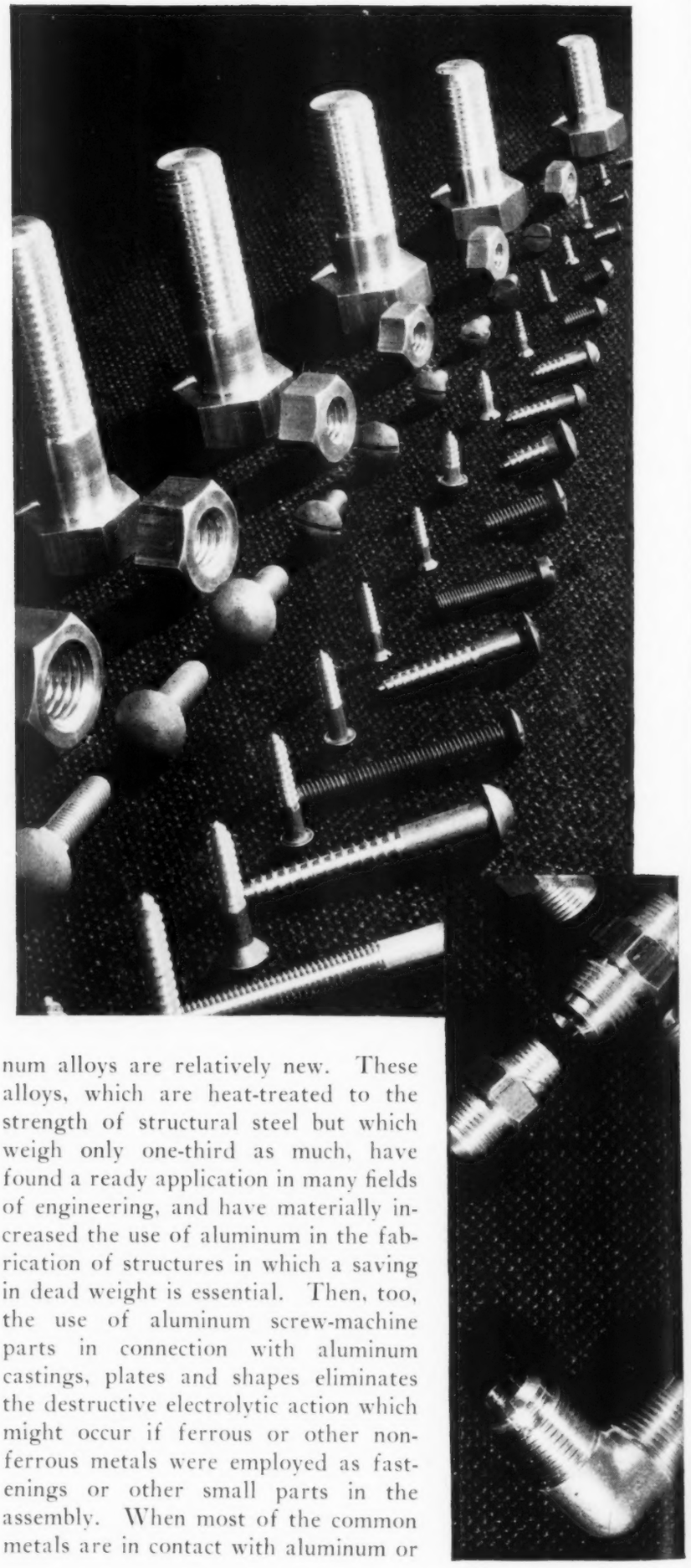
As shown in this article, by employing different compounds, rubber having widely different physical and chemical characteristics and specially adapted to meet certain conditions, are available commercially. Also, some rubber manufacturers have developed a line of mounting units. It is often possible to use such mountings instead of having them made special, thus obtaining considerable savings in cost.

✦ ✦ ✦

Aluminum Parts for Aluminum Structures

By SETH G. MALBY
President,
Aluminum Screw Machine Products Company

Bolts, screws and fittings of aluminum used in products of the same material save weight, improve appearance, prevent electrolytic action



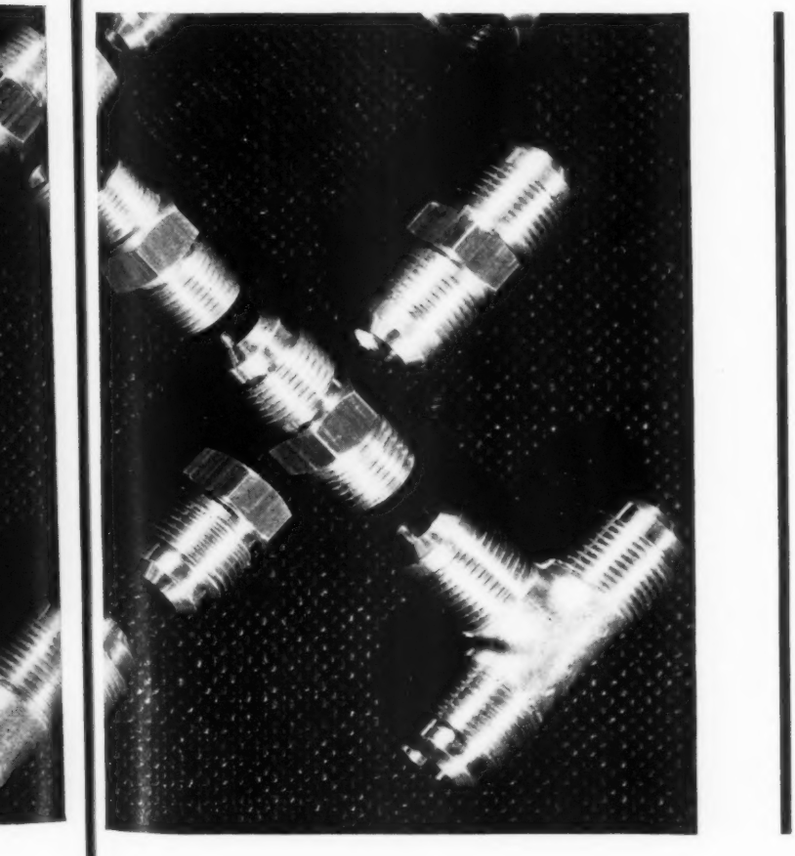
IT IS not necessary to ask a doctor what will happen when the vital organs in the human system wear out—nor is it necessary to ask an engineer what will take place in an engineering structure if any of the small nuts, bolts, screws, rivets and nails which hold it together fail. These tiny screw-machine parts and their companions, rivets and nails, may seem insignificant in comparison to the large castings, plates and shapes which go to make up the structure, yet the very life of the product may hinge on their proper selection and use. This is particularly true where aluminum members are to be employed.

Screw-machine parts made of aluminum alloys are relatively new. These alloys, which are heat-treated to the strength of structural steel but which weigh only one-third as much, have found a ready application in many fields of engineering, and have materially increased the use of aluminum in the fabrication of structures in which a saving in dead weight is essential. Then, too, the use of aluminum screw-machine parts in connection with aluminum castings, plates and shapes eliminates the destructive electrolytic action which might occur if ferrous or other non-ferrous metals were employed as fastenings or other small parts in the assembly. When most of the common metals are in contact with aluminum or

its alloys, the aluminum member is the one most likely to be attacked. In this connection, copper alloys are particularly harmful, whereas steel, either bare or plated with zinc or cadmium, is less harmful. While galvanic action can be avoided by insulating the dissimilar metals from each other, it is much simpler to fabricate the entire structure from the same material.

Entirely aside from the prevention of electrolysis and the reduction of weight is the advantage which aluminum screw-machine products offer in resisting corrosive influences. Aluminum is resistant to the corrosive action of many chemicals. Sulphur-laden gases, for example, are present in the atmosphere in some industrial plants and corrode iron and steel but have no effect on aluminum. Consequently, the metal is specified for much industrial equipment, and the fastenings and fittings must match.

Aluminum screw-machine products are manufactured in accordance with recognized standards, and include nuts, bolts, machine and wood screws. The latter are produced in sizes varying from Nos. 2 to 24, inclusive, with flat, round, truss and oval heads. Machine screws are available in diameters from No. 4 to $\frac{3}{8}$ in., and in lengths from $\frac{3}{16}$ to 3 in., with flat, round, oval, truss, fillister and finishing heads. Hexagonal, carriage, mushroom head and fluted shoulder bolts can be obtained in varying sizes and lengths with burrs and with cap, square and hexagonal nuts to fit. These parts are fabricated from the strong aluminum alloy, 17S. When properly heat-treated and aged, the strong-alloy screw-machine products have a minimum tensile strength from 50,000 to 55,000 lb. per sq.in., equivalent to structural steel.



The standard classes of thread fit commonly used with aluminum screw-machine-products include loose fit, free fit and medium fit. Upset-head, rolled-thread screws are generally made to the free fit standard of the National Screw Thread Commission; cut threads in accordance with the medium fit standard. Generally speaking, cut threads are more accurate than rolled threads. This condition is, however, gradually changing, and if close tolerances are maintained on the screw-blank, there is no reason why rolled threads cannot be made as accurately as cut threads and at lower cost.

In the fabrication and assembly of airplanes and dirigibles, lightness is recognized as a necessity, and since aluminum weighs only 0.1 lb. per cu.in., the aircraft designer makes extensive use of the metal. The application of aluminum screw-machine products to the main members also eliminates the dangers resulting from the use of metals not closely associated in the electromotive series. The individual preference of the designer usually determines whether the tubular and sheet-metal sections of the wings, fuselage, pontoons or landing gear are to be assembled by means of rivets or screws, nuts and bolts. Screw-machine products are employed where disassembling of the members may be necessary at some time, and in positions where rivets cannot be driven easily. They are also used in the fabrication of many of the delicate instruments upon which the aviator must depend for his bearings. Wooden sections of aircraft are usually assembled with aluminum wood screws because the corrosion resistance of the metal is especially important.

Other forms of transportation make extensive use of aluminum screw-machine products. They are used in railroad cars and coaches, street cars, automobiles, trucks and buses, outboard motors and marine motors, and in ships.

Finally, many electrical appliances, such as vacuum cleaners, washing machines, refrigerators and radios are assembled by means of aluminum screw-machine products. For such uses these products again reduce weight where it is a distinct sales advantage, and also match the color of the aluminum parts of the appliance where eye appeal is important.

Organizing a Product Development Program

How an industry is applying the scientific method to the improvement of its basic product

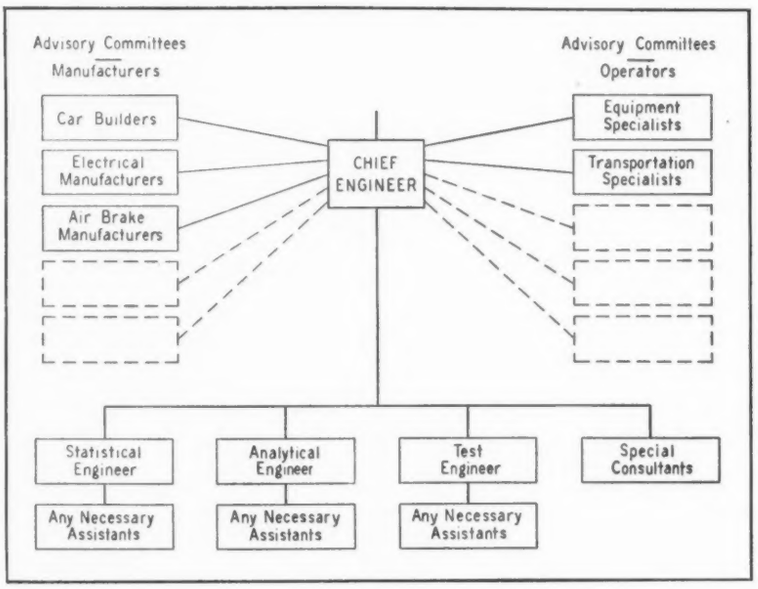


Fig. 1

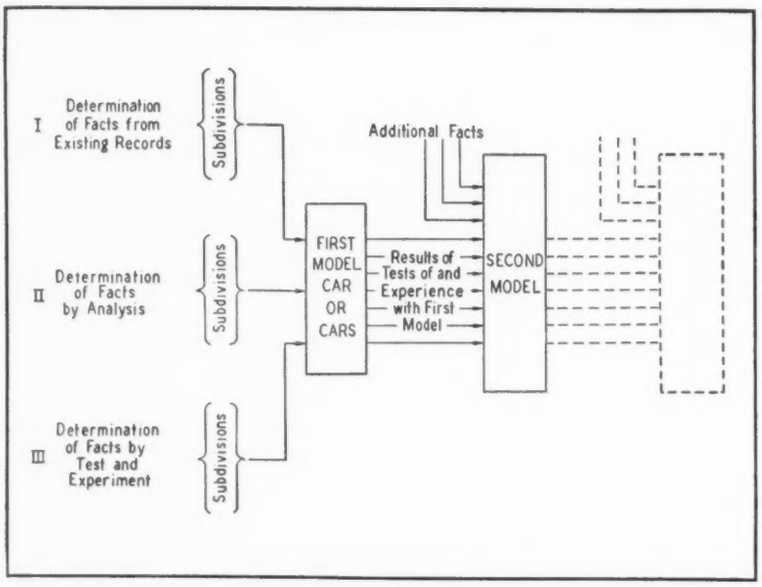

I Determination of Facts from Existing Records
II Determination of Facts by Analysis
III Determination of Facts by Test and Experiment
Subdivisions
Subdivisions
Subdivisions
Additional Facts
FIRST MODEL CAR OR CARS
Results of Tests of and Experience with First Model
SECOND MODEL

Fig. 2

ALTHOUGH most of us have very positive opinions about the shortcomings of the trolley car the chances are that very few readers of *Product Engineering* will have any definite part in improving that much abused vehicle. Nevertheless, the program of industry research set up by the Electric Railway Presidents' Conference Committee is well worth study by any product engineer as an example of careful research planning.

It is unnecessary to repeat all the reasons why the trolley car was "on the way out" according to popular estimate, freely expressed. Suffice it to say that the heads of the operating companies and the builders of street railway cars and accessories were well aware that the time had come to unite in an effort to save their industry. Accordingly, when the proposal was made that the above mentioned committee be formed to organize a research program, there was little difficulty in collecting the necessary funds from the operating companies and the equipment builders. This happened about a year ago. Since then a three-year research program has been planned and inaugurated under the direction of a chief engineer, Dr. C. F. Hirschfeld, of the Detroit Edison Co. The staff of the chief engineer is organized as shown in Fig. 1.

The project may be defined as the development of an economically better street railway car. Obviously, the best

modern cars are not entirely suitable. Quite as obviously, the present independent cut-and-try methods of design will not produce the desired result. It is proposed, therefore, to adopt the research method of attack: (1) definition of the problem; (2) determination of significant facts; (3) application of these facts.

It is easy to set down these three steps but not so easy to take the first one. What factors determine whether or not a street car is "economically better"? The builder has one criterion, the operator another, the rider still another. The first task of the engineering staff was to collect as many of these opinions as possible, and from them to work out a program. This took several months, but finally a program that met the approval of the committee was developed and work commenced according to the outline of Fig. 2. This chart covers the second step in the research method, ascertainment of facts. The subdivisions designated by Roman numerals are further broken down in Figs. 3, 4 and 5.

Determination of facts from existing records (Fig. 3) is largely a statistical job. Analysis (Fig. 4) implies the application of engineering reasoning to certain phenomena that seem more or less mysterious until they are thus clarified. Every product engineer has had experience of this sort. For the testing and experimental work (Fig. 5) a laboratory of some sort is needed. In this case such a laboratory was found in the shops and a section of track owned by the Brooklyn & Queens Transit Corporation, where work is now going on.

Several articles could be written on each of these charts but as this brief statement is one of method rather than of application there is no point in attempting further development of detail. This method has been worked out for a whole industry, a really remarkable evidence of the cooperative spirit that exists in American industry if the means can be found to bring it out, but it is equally applicable to the problem of the smallest company, or even to the task of an individual product engineer.

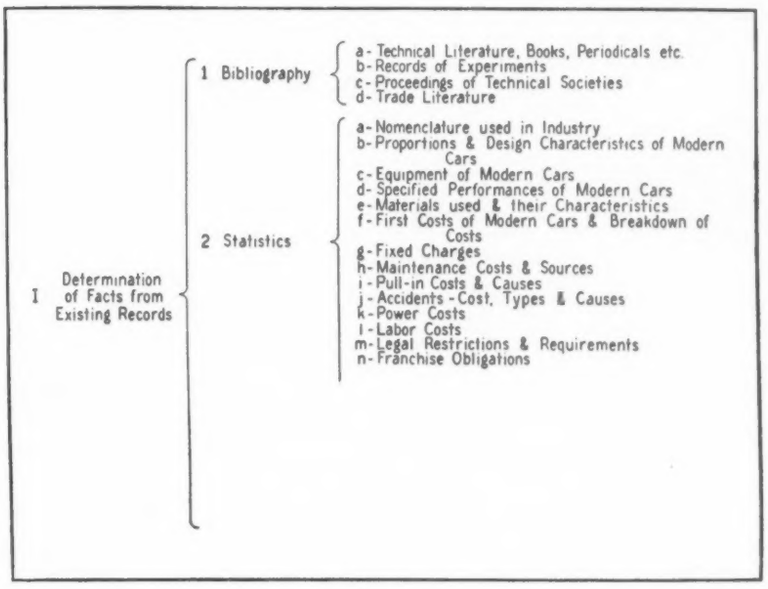

I Determination of Facts from Existing Records
1 Bibliography
a - Technical Literature, Books, Periodicals etc.
b - Records of Experiments
c - Proceedings of Technical Societies
d - Trade Literature
2 Statistics
a - Nomenclature used in Industry
b - Proportions & Design Characteristics of Modern Cars
c - Equipment of Modern Cars
d - Specified Performances of Modern Cars
e - Materials used & their Characteristics
f - First Costs of Modern Cars & Breakdown of Costs
g - Fixed Charges
h - Maintenance Costs & Sources
i - Pull-in Costs & Causes
j - Accidents - Cost, Types & Causes
k - Power Costs
l - Labor Costs
m - Legal Restrictions & Requirements
n - Franchise Obligations

Fig. 3

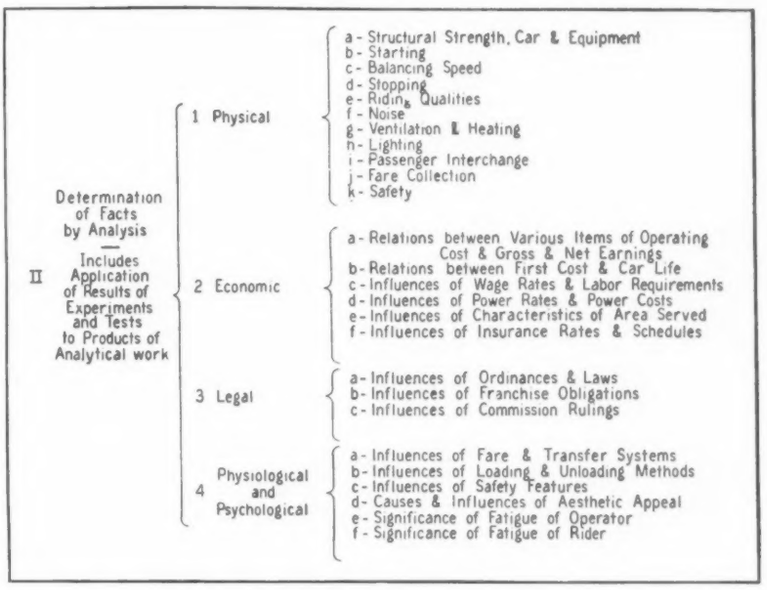

II Determination of Facts by Analysis — Includes Application of Results of Experiments and Tests to Products of Analytical work
1 Physical
a - Structural Strength, Car & Equipment
b - Starting
c - Balancing Speed
d - Stopping
e - Riding Qualities
f - Noise
g - Ventilation & Heating
h - Lighting
i - Passenger Interchange
j - Fare Collection
k - Safety
2 Economic
a - Relations between Various Items of Operating Cost & Gross & Net Earnings
b - Relations between First Cost & Car Life
c - Influences of Wage Rates & Labor Requirements
d - Influences of Power Rates & Power Costs
e - Influences of Characteristics of Area Served
f - Influences of Insurance Rates & Schedules
3 Legal
a - Influences of Ordinances & Laws
b - Influences of Franchise Obligations
c - Influences of Commission Rulings
4 Physiological and Psychological
a - Influences of Fare & Transfer Systems
b - Influences of Loading & Unloading Methods
c - Influences of Safety Features
d - Causes & Influences of Aesthetic Appeal
e - Significance of Fatigue of Operator
f - Significance of Fatigue of Rider

Fig. 4

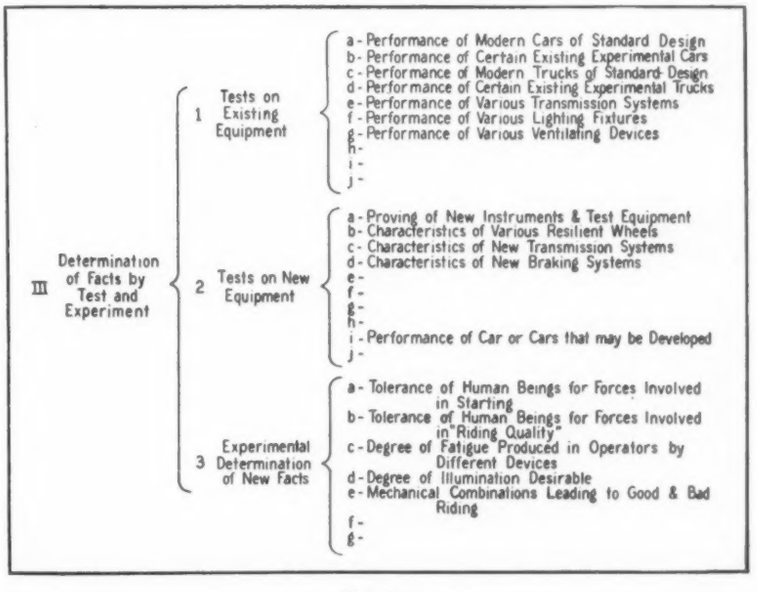
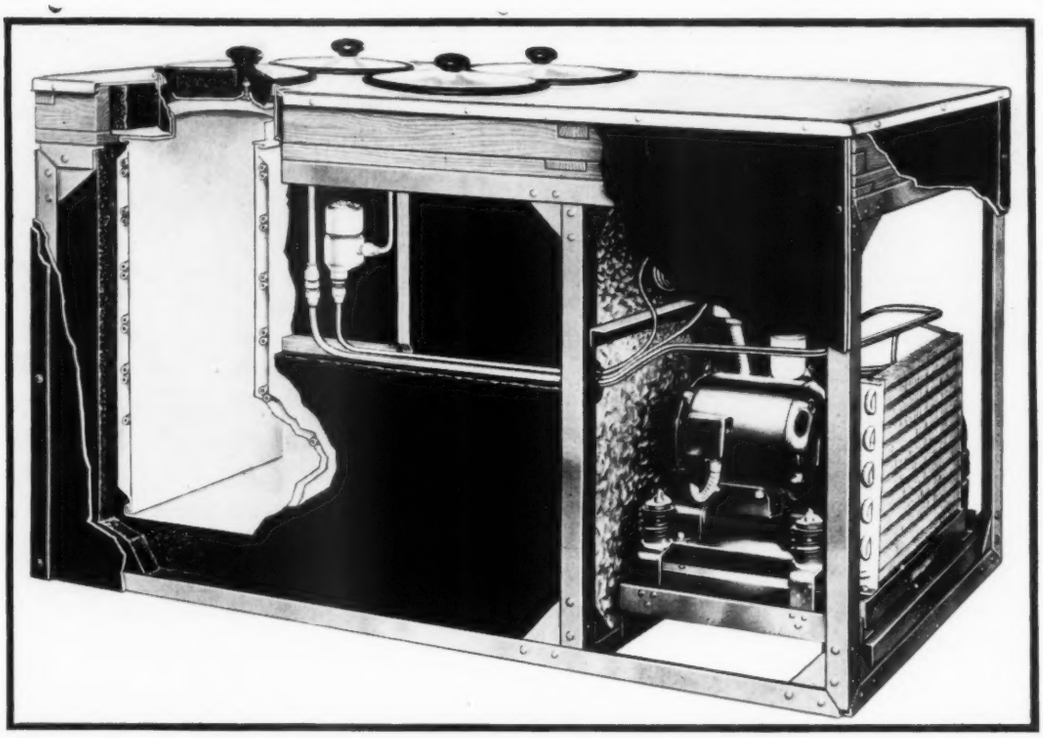

III Determination of Facts by Test and Experiment
1 Tests on Existing Equipment
a - Performance of Modern Cars of Standard Design
b - Performance of Certain Existing Experimental Cars
c - Performance of Modern Trucks of Standard Design
d - Performance of Certain Existing Experimental Trucks
e - Performance of Various Transmission Systems
f - Performance of Various Lighting Fixtures
g - Performance of Various Ventilating Devices
h -
i -
j -
2 Tests on New Equipment
a - Proving of New Instruments & Test Equipment
b - Characteristics of Various Resilient Wheels
c - Characteristics of New Transmission Systems
d - Characteristics of New Braking Systems
e -
f -
g -
h -
i - Performance of Car or Cars that may be Developed
j -
3 Experimental Determination of New Facts
a - Tolerance of Human Beings for Forces Involved in Starting
b - Tolerance of Human Beings for Forces Involved in "Riding Quality"
c - Degree of Fatigue Produced in Operators by Different Devices
d - Degree of Illumination Desirable
e - Mechanical Combinations Leading to Good & Bad Riding
f -
g -

Fig. 5



Enameled steel side, stainless steel top, cork insulation sealed with asphalt flexible rubber seal sleaves, and hard rubber lid frames make up this Frigidaire cabinet

Corrosion-Resistant and Insulating Materials Featured in Dairy Machinery

By GEORGE S. BRADY
Managing Editor, Product Engineering

WITH the possible exception of the chemical industry there is no place where there are such exacting demands upon the designer for the incorporation of corrosion resistance into machinery and equipment as in the food industry. In this latter industry there is also the added factor of bacteriological cleanliness which must be assured by the use of materials that will not only clean easily but will appear clean. More widespread adoption of stainless steels was, therefore, a keynote of the Sixth Annual Dairy Industries Exposition held at Atlantic City, October 26 to 31. Monel metal still holds a place in a number of applications, and pure nickel is being used for parts of pasteurizers and other apparatus where milk has contact with metal. Since milk-products machines and equipment are always washed and sterilized daily, they are designed also for ease of access and simplicity of dismantling.

Storage and shipping containers as displayed at the Exposition form an interesting study in the use of materials. Efficient insulation, strong construction and light weight are the factors of design. The American Car & Foundry Company has a solid CO_2 container of rustproof sheet steel with 3 to 8 in. of kapok insulation between the inside and outside steel boxes. A resilient gasket seals the lid. Containers made by some companies use granulated cork or corkboard for the insulation. Glacifer Systems, Inc., uses a steel cabinet insulated with 2 to 5-in. corkboard. The Trenton "Icefin" ice cream cabinet has sides of lacquered steel with a 2-in. balsa wood top covered with Allegheny metal. Cork is used for insulation in this as in most of this type of cabinet. Truck bodies have been designed by several companies for cold delivery of various food products, and these are built up with corrosion-resistant metals insulated as above.

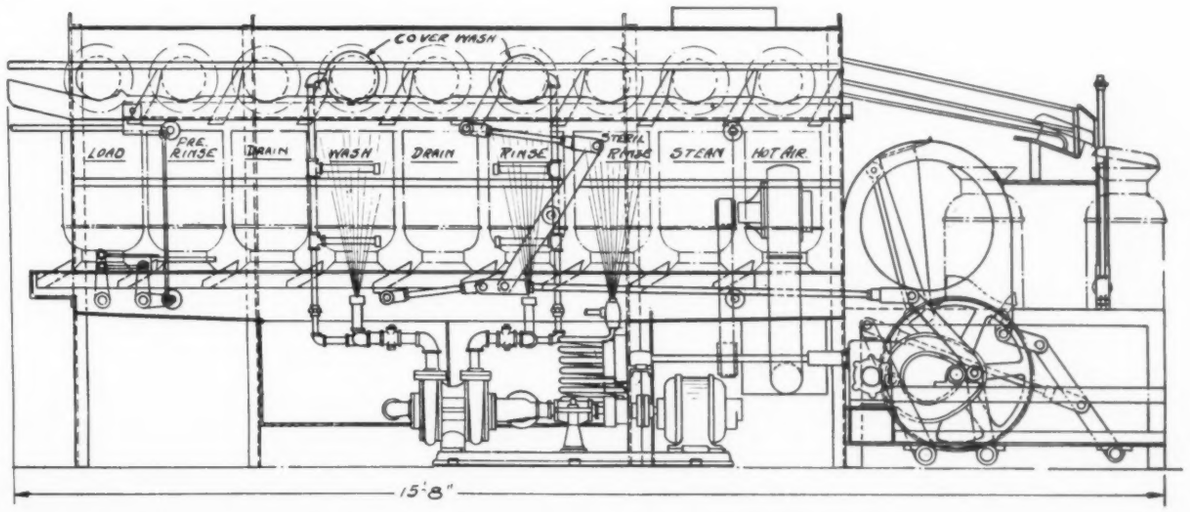
Perfect sanitation must be insured in such ordinarily simple assemblies as heating or cooling coils. In the York milk cooler the tubes are

straight with open ends for easy cleaning. The tubes are of polished seamless pure nickel with the ends rolled into the return heads. The hinged covers for the tube heads are of cast brass heavily tinned. The tubes are insulated with granulated cork and the jacket is of terne plate painted with white lacquer, or in some cases this jacket is of stainless steel. On the Heil equipment the manhole covers are of Allegheny metal or Nirosta.

Considerable difference of opinion exists among designers as to the best methods of insulation, and it is apparent that approximately equally effective results can be obtained with different materials when properly proportioned. Granulated cork, corkboard, kapok, and aluminum foil are some of the insulating materials employed. The Oakes & Burger pasteurizer has asbestos insulation between the outer iron shell and the inner copper lining. In the Manning heating-coil vat a 1-in. flax fiber board is employed for insulation between the outer and inner metal sheets. In this case the vat itself is made of sheet copper heavily tinned, although vitreous-enameled steel is also used. This class of equipment was formerly made of red cypress wood finished with spar varnish, and is still preferred in wood by many users. It is to be noted in this connection from a review of equipment featured at the Show that while wood still persists in those machines which were originally designed before the advent of the newer corrosion-resistant aloys it is not usually met with in new types of machinery. One 6-compartment milk holder and distributer is lined with pure nickel or stainless steel and has an outer cover of porcelain-enameled steel with pure nickel trimmings. Valves are also of nickel.

Aluminum is entering the field of dairy and food equipment and has extensive possibilities where it does not come into contact with strong alkaline solutions. In an automatic citrus juice extractor, for example, the large wheels that revolve the fruit holders are of cast aluminum alloy, the gripping fingers in the holders and the knife being of stainless steel. The fact that many alloys of aluminum are now made with strengths equal to those of most grades of mild steel places this material in a favorable position for general construction parts particularly because of its non-corroding silvery appearance. On the Oakes motor-driven pasteurizer the motor and driving head housing is of aluminum.

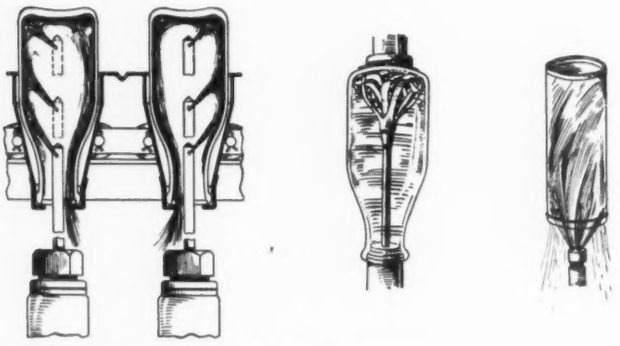
Special machines for the dairy industry are designed with the idea that they will be operated by non-mechanics, and that they must be easily dismantled for frequent cleaning and sterilization. Fully automatic operation is being demanded. This type of equipment includes filling machines for ice cream cups and cheese packages, chocolate-coating machines for ice cream and yeast. Many of these machines consist essentially of hopper mechanism, heating tank, filler mechanism, capper or closing mechanism, and conveyor belts. The latter, in the case of small machines, may be of fabric, but in one case the conveyor consists of two continuous coil springs running over driving drums. It is notable that on most of these machines standard commercial units such as motors, thermostatic controls, speed reducers and pumps are incorporated. In the automatic Eskimo Pie machine the thermostat is hermetically sealed in the chocolate tank, and a gear pump is used for the chocolate. Incidentally, this entire machine can be completely disassembled for cleaning by releasing only eight thumb screws. Chromium plating is used extensively on parts of small ma-



SIMPLICITY of design characterizes the McKinley milk can washer. One cam and gear combination operates entire machine, including kickers, recovering device, pump and blower. Arc-welded steel construction is used

chines, although stainless steel and pure nickel are used for some parts in contact with the food products.

The McKinley can washer, shown in cross-section, illustrates typical problems involved in some of the larger machines of the industry, can and covers are moved along progressively by kickers to the stations where they are prerinsed with cold water, washed with soda solution at 140 deg. F., rinsed at 180 deg. F., and at 180 deg. F., sterilized with steam, and dried in hot air. Thermometer control is used. One 5-hp. motor drives the machine and the pumps. One cam and gear mechanism operates the kickers for cans and covers and the rotary recovering device. Alemite lubrication is employed.



THREE METHODS of solving an internal washing problem used by different companies

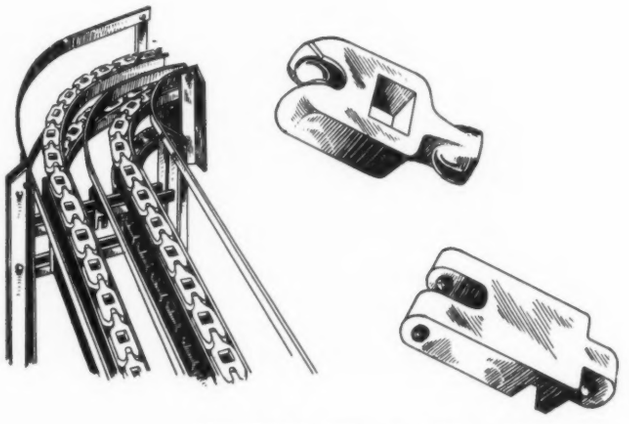
Problems of a similar nature are sometimes solved by different companies in different ways. The internal washing of bottles and cans, illustrated above, is an example. The air brush on the Yundt bottle-washing machine, shown at the left of the illustration, works in two stages. Two tubular nickel spindles travel up and down on a single cast-aluminum carriage with valve timed to release the water blast in a fan-shaped spray, one spindle on each side of a bottle to prevent water clogging. The "National" bottle washer uses a multi-winged brush of special composition rubber. The brush revolves in the bottle at the speed to give a scrubbing friction weight against the sides, and the water stream is forced from the end of the spindle. The brush withdraws into a protector tube, which brings it back to shape. The Oakes & Burger ice-cream can washer uses a flat sheet of water injected tangentially from a revolving tubular spindle, as shown at the right of the illustration.

Most of the conveyor chain in the larger machines such as bottle washers is made up of links of malleable iron or bronze pinned together to run without lubrication. In the Lathrop-Paulson bottle conveyor a ball and socket link is used which will operate in either direction on curves of 7-in. radius. Sealing of the bearings in all types of milk machinery is receiving great attention since these bearings must never allow oil or grease to seep into the food product nor be permitted to catch and retain any small quantities of milk that would ferment and propagate bacteria. Anti-friction bearings have not been generally adopted for the machines proper because of general low speeds.

In milk dryers the large rolling drums are made from alloy cast iron of fine granular structure which can be polished down to a satin-smooth finish. The structure of the iron is important, since the drum not only must retain its high luster but it must also offer high heat transference.

In the large tank equipment designed by Pfaudler the tanks are of open-hearth steel with the inner shell lined with porcelain enamel and the outside painted with oil enamel. The designers of this company also adhere to glass enamel for lining mixers, hoppers, and milk warmers as they claim it eliminates all metallic taste when using high-acid creams. They use cork and corkboard for insulation.

Appearance is an important item in the design of dairy equipment as this industry is constantly thrown open to public inspection. Moving parts, especially those where lubrication is used, are completely housed. Outside surfaces of machines such as pasteurizers are finished in porcelain enamel, stainless steel, or aluminum lacquer. Stainless steel, Monel metal, and pure nickel are used freely for trim on many types of machines. Welds and silver-soldered joints in these metals are polished down to smooth surfaces.

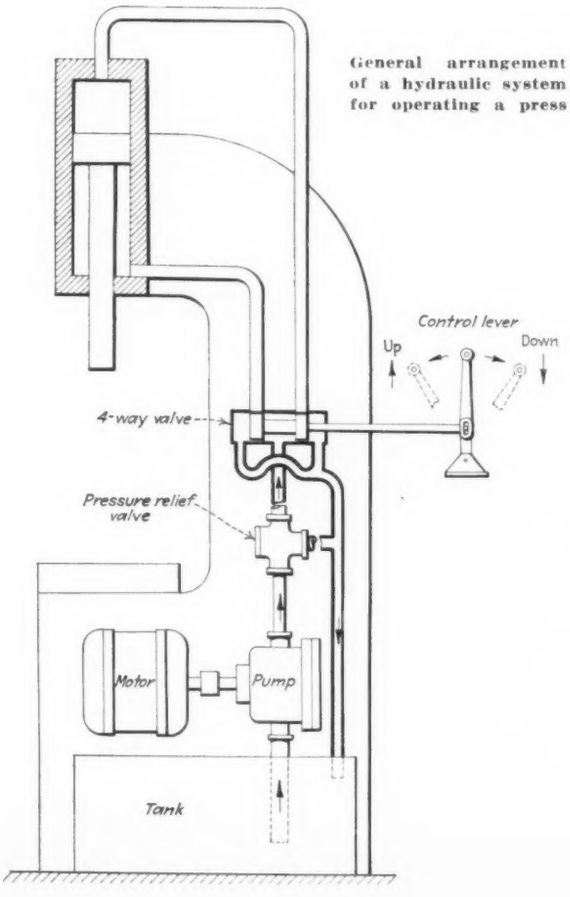


CONVEYOR belts on bottle and can machines must make sharp curves in both directions and double over sprockets of relatively small radius. The standard type of pinned link and the Lathrop-Paulson ball and socket link are shown

How to Design for Hydraulic Operation

By H. F. VICKERS
President and Chief Engineer, Vickers Incorporated

In this first of a series of two articles, the author explains and illustrates the calculation of cylinders, pumps, piping, tanks and valves for hydraulic control systems. The second article will present further detailed information on the application of hydraulic systems



General arrangement of a hydraulic system for operating a press

IN designing any system we assume that certain fundamentals must be taken into consideration, and if these requirements are met within reasonable limits, a successfully operating machine will result. But the failure to consider and provide properly for any one factor in a hydraulic system will result in an unsatisfactory machine, or may entirely ruin its operation.

It is extremely difficult to tell where the trouble lies after the machine is set up, unless a complete analysis and test of each unit is made. The oil, being inclosed in pipes and valves, gives no external evidence of the location of the trouble. This trouble may show up as noise, oil heating, too slow operation, lack of power, or excessive power consumption. Probably all of these troubles will be present in some degree. Therefore, it is important and economical to make the analysis of the entire system while it is being designed, and thus provide for all contingencies before the design is taken off the drawing board.

Very little modern information is available in printed form on the subject of oil-pressure operated mechanisms, generally called hydraulic mechanisms, and it is usually the simpler and apparently unimportant things that cause the most trouble; such as air getting into the system with no means of getting rid of it automatically, or pipes that are too small for returning the oil to the supply tank, thus carrying air into the oil.

The first consideration in the development of a hydraulic system for a machine is, of course, the force necessary to accomplish the desired result. Next of importance is the maximum speed at which this force must move the mechanism. In a high-speed machine, questions of acceleration, time and rate of reversal, elimination of shocks, valve hammer, pressure surges, and special control, must be considered. The smaller the unit, the less trouble these operations cause. But as the masses and speeds become larger and higher they assume major proportions. Therefore, they should be considered in the original design. In fact, they are the fundamental requirements from which all the design must proceed and are determined by the performance requirements.

It is probably better in this study of practical

applications to take up the simpler conditions first and go into the more complicated considerations later. The simplest circuit consists of a cylinder assembly, pump, power supply, control valve, supply tank and suitable pipes to convey the oil properly from one to the other and back to the supply. A relief or safety valve in the pump line to prevent excessive pressures or overloading of motors is necessary.

The speed of operation is fixed by the capacity of the pump and the cylinder size. The question of pipe sizes, cylinder sizes, pump capacity, motor hp., volume of tank and size and type of valves must be considered and each properly proportioned to assure an economical job.

Taking the example of a simple hydraulic press, let it be assumed that the pressure required on the ram is to be 5 tons, and that the ram must move at the rate of 100 in. per min. The first step would be to determine the operating pressure, which factor is largely determined by the type of pump that will be used.

There are a great many types of pumps, each suitable for certain work and each having its own advantages and disadvantages. Some will work at high pressures and some must be worked at lower pressures. The question of first cost, efficiency in power consumption, life of wearing parts, ease of making renewals of parts, and the question of whether an expert will be available or necessary, to make the repairs, must be considered. Everything else being equal, higher pressures are more economical on account of the smaller cylinder sizes, pipes, valves, and oil supply required. The higher pressures bring difficulties in higher stresses, more careful packing designs, leaks, balanced valves, and similar factors.

Assume that for the installation under consideration, there is a pump available which meets all requirements and operates at 1,000-lb. per sq.in., giving at this pressure an over-all mechanical efficiency of 85 per cent and having a slip characteristic of 10 per cent or less. The area of the ram in square inches must be sufficient to produce 5 tons or 10,000 lb. on the ram at 1,000 lb. per sq.in. of area. As 10,000 divided by 1,000 is 10 sq.in., a diameter of 3.57 in. meets this requirement.

For a speed of 100 in. per min., 10 sq.in. moving 100 in. per min. produces 10×100 or 1,000 cu.in. per min. This divided by 231 cu.in. per gal. gives 4.33 gal. per min. at 1,000 lb. per sq.in. pressure to be delivered. Most pumps have more or less slip at these pressures, which materially slows down the machine. As it was assumed that the pump used will have a 10 per cent slip, the necessary pump capacity at zero pressure, which is the usual way of rating a pump, must be increased by 11 per cent. It is easier and better to obtain information regarding the necessary capacities of pumps, directly from the charts of the pump manufacturers, which charts show the delivery and horsepower consumed at all pressures and speeds.

The horsepower required is calculated from the formula: Hp.=gal. per min. at discharge pressure $\times$ pressure $\times$ 0.0000583 divided by the per cent over-all mechanical efficiency.

$$\text{Hp.} = \frac{\text{Gal.} \times \text{press} \times 0.0000583}{\text{Per cent Eff.}}$$

In this present problem, let it be assumed that a certain pump having a capacity of 4.3 gal. per min. at 1,000 lb. per sq.in. pressure and 4.6 gal. per min. at zero pressure, is available. Applying the above formula, using 4.3 gal. per min. and 85 per cent mechanical efficiency, this would require 2.9 hp. to be delivered to the pump. Its volumetric efficiency is 4.3 divided by 4.6 which equals 93 per cent. That is the slip is 7 per cent. A 3-hp. motor is required.

In order to convey the oil with a loss of not more than a few pounds pressure, the size of the control valve should be such that the velocity of the flow in any of the passages will not be more than 10 ft. per sec., preferably 5 ft. per sec. Conditions will vary this figure somewhat. A 4-way balanced valve of any type is suitable, but it should not allow leakage through its contact points as this affects the efficiency of the system and is a direct loss. If possible, the design of the valve should be such as to be repaired readily.

Particular care must be used in the selection of a relief valve, as most relief valves will produce a terrific pounding or squeal at some point in their range. This difficulty can be overcome by the use of a valve that is designed and built especially for the particular type of service. The ordinary pop-type valve will protect the equipment from excessive pressures if it has capacity enough, but it is subject to the troubles of noise and rapid wear at higher pressures.

Selection of pipe sizes is an important consideration. The velocity of flow through the pipe should be less than 5 ft. per sec., if the pipes are fairly short, and less than 3 ft. per sec., if the pipes are long. In the problem under consideration, the piping must handle 1,000 cu.in. of oil per min. The required pipe size for a maximum velocity of 5 ft. per sec., will then be:

$$\frac{\text{cu.in. per min.}}{720 \times \text{velocity in ft. per sec.}} = \frac{1{,}000}{720 \times 5}$$

$$= 0.28 \text{ sq.in. area}$$

This area corresponds to a diameter of 0.6 in. Practical considerations will dictate the use of a $\frac{3}{4}$-in. pipe. A $\frac{1}{2}$-in. pipe would do if the length of the piping were less than 10 ft. in total length.

Intake piping from the oil tank to the pump should be as short as possible and in the problem under consideration should be of $\frac{3}{4}$-in. or 1-in. pipe, and it should not be more than 4 ft. long. The fewer the bends and elbows, the better.

The return pipe from the working cylinder to the oil tank should be arranged so that the oil will be returned under the surface of the oil level in the tank and in such a direction so that the returning oil will not be directed against the intake pipe to the pump. Failure to do this will cause air to be carried into the oil and a general foaming and heating of the oil will result. There will be excessive noise and probably an unsteady, jerky motion of the ram. An unsteady motion of the ram is caused by air in the system.

Incidentally, oil will not foam no matter how hot it may be, as long as the temperature of the oil is less than its volatilizing temperature, providing there is no air circulating through the pump. Air in the pump makes oil foam.

Oil leaks are probably the greatest source of annoyance and dissatisfaction for users of hydraulic equipment, but may be entirely eliminated by proper design and care in setting up the equipment. One trouble encountered by those new to this type of design is the lack of providing sufficient metal in the pipe flanges to prevent spring on account of the high pressures involved. Spacing bolts too far apart, and providing gaskets that are too thick, are other sources of trouble. Contrary to general supposition, thick gaskets are bad because of the appreciable surface that is exposed to oil pressure, causing the gasket to blow out between the bolts. A joint that is thick enough to prevent spring within itself and has flat surfaces packed with a thin paper gasket varnished on one side and held with properly spaced bolts, will not leak. Well threaded pipes and fittings of the right weight for the pressure, when assembled with clear finishing lacquer and drawn up tight as possible will not leak.

For hydraulic work without an accumulator, it is perfectly safe to use standard pipe and fittings up to $1\frac{1}{2}$-in. size for pressures of 500 lb. per sq.in. or less. For pressures ranging from 500 to 1,000 lb. per sq.in., standard pipe with hydraulic fittings may be used for pipe sizes up to 2 in.

To assure user satisfaction, it is the duty of the engineer to specify for his product: installation requirements, driving unit, working fluid, lubrication, necessary service attention, and similar factors. Fundamental requirements for a hydraulic system to operate satisfactorily are summarized here

✦ ✦ ✦

For the working fluid, specify good grade motor or machine oil having a viscosity as recommended by the pump manufacturer.

Specify oil system to be kept clean and free from gritty foreign matter. Core sand and metal chips in new installations must be carefully removed. A coat of good paint binder will help. Make provision for frequent oil change, oil to be filtered or replaced with new oil.

Pump intake pipe connection to the oil tank should be 2 to 3 in. above the bottom of the tank.

Provide sufficient tank capacity to keep temperature below the critical point. The temperature rise is a function of the heat generated, and the amount of heat that can be dissipated into the air. A general rule of thumb is to have 2 gal. tank capacity for each gal. per min. of pump displacement. This, of course, varies with the installation and is dependent on the total area of pipe and tank exposed to the air.

Use large pipes, not less than size of pump fitting. Intake pipes that are too small will create a howl. Air leaking into the intake pipe will make snapping noises. Cored oil passages should be sandblasted and pickled in hydrofluoric acid to remove scale.

All return pipe must be returned under the surface of the oil to prevent foaming and carrying of air into the oil. Do not connect any return pipes to the intake of the pump as this short circuits the oil flow and will cause high temperatures and foaming because of the lack of the opportunity for the oil to release its air when returned to the tank.

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

December, 1931

. . . "No longer is it enough to say that a product is useful, or economical, or convenient. Today it must have beauty as well as these other attributes in order to enjoy a ready sale. And beauty is composed of two impressions upon the sense of sight—design and color" . . .

—FRED AUMUELLER,
Class and Industrial Marketing.

Medicine—Not Bleeding!

OF WHAT utility is a manufacturing plant if it does not have a product that can be sold at a profit? And what is to be done when the product is afflicted with sleeping sickness and does not sell?

Once it was standard medical practice to draw off the patient's blood to revive him. The terrible drain on the lifestream at a time when the sick man needed every red corpuscle he had often stirred him into quickened pulse action, but if he sank back again there was no reserve energy and it was time to buy flowers. There are many sick products in American industry today, and there are apparently too many executives using the bleeding process to try to revive them.

We went through a cycle of pressure on the shop when the introduction of efficiency in manufacturing processes and control effected large savings in product costs, but the percentages to be saved there are not so high today. Savings must be made in the product itself. But at the same time sales forces are confronted with the fact that better and better features must be offered even when prices are reduced. It is not a question of "cheapening" the product by substituting cheaper materials, eliminating parts, or making by higher mass production standards. In fact, many examples have arisen this year to show that the lower prices had to be quoted on smaller quantity production. Real engineering medicine had to be applied.

This is no time to effect picayune savings in the engineering department. Money now spent on research and product development will be seen in the mounting sales curve, while money saved by skimping of values, or limiting the effectiveness of the engineering department by "saving overhead" is simply playing into the hands of competitors. Almost every depression since 1837 has been worse than the one preceding it, but after each there has come a business revival greater than the one before. There have been gold rushes, land booms, railroad expansions—but this time something indicates a mechanical and electrical development surpassing anything before known. The products that show advanced design and real value are selling even today. The products that show daring engineering development are the ones that are going to make upward sales curves in the business revival. Let engineering go forward—medicine in the form of more and more research, but no bleeding!

■

Materials—the Yardstick of Progress

ADVANCES in engineering development are apparent, but not easy to measure. The ancients dreamed of power operated devices, of automotive vehicles and even of the airplane. But they remained nothing but dreams until the engineer, the chemist and the metallurgist made their dreams possible. Can we find a better yardstick for this development than materials?

Stone and copper alone did little toward real advancement. The advent of iron with its cousin carbon steel, marked a definite step ahead. Alloy steels mark a real milestone of progress. Lighter alloys of aluminum and magnesium are also playing a part, while the advances in plastics have opened new possibilities to the product engineer. Devices that were difficult to produce in castings or by sheet-metal forming are usually easy to mold. And we now have such a variety of plastic materials that almost any desired characteristic, both mechanical and electrical, can be found without difficulty.

The part played by materials in our advances during this century can hardly be over-estimated. Their importance should be appreciated sufficiently to make every product engineer realize the necessity of keeping informed on all developments in the line of materials. By having data on new materials always available the engineer can frequently solve new problems as they arise, and without costly experiment with unsuitable materials.

Keep your file of material data complete!

■

After It Happens

ONE of the late Senator Morrow's wisest sayings was his comment on business revival, to the effect that he would probably know about it two or three months after it happened. The same philosophy may well be applied to product development. Many new products are coming along, and many of us will not know about them until several months after they have happened.

Television is a case in point. In September an attempt was made at a demonstration on a ten-foot screen at the Radio Show. The results were not very promising. A month later a large audience filled the New York Theatre and witnessed a stage demonstration, again on a ten-foot screen, that continued successfully for over half an hour with only one break while an overheated lamp cooled off. Those who saw both efforts were amazed at the progress that had been made in thirty days.

Television is a long way from commercial success but it is coming fast. So are other new products. It will not do to ignore them for they may wreck existing industries. Keep informed.

■

The Index

IN this number of *Product Engineering* will be found an index covering the year January-December, 1931. It has been arranged for convenient cross reference to products, general subjects, and authors. For the use of designers and specification writers, the items relating to the new materials and parts that have appeared during the year are arranged in handy form after the New Materials and Parts section.

Plateaus of Excellence

TO those who attend regularly the annual and biennial expositions of machinery and equipment of the various industries it becomes apparent that there are certain levels of design on which the products of given industries are likely to perch and remain. It is noticeable to the observer that the new machinery developments of one industry may have a high excellence in detail of some one or two points of design—as, for example, factors of appearance in office appliances—but may be unprogressively designed at other points.

Why these levels of design should exist may be due to many factors, but one outstanding reason seems to be that the executives and engineers of an industry watch particularly and jealously the developments of competitors, and follow each other's trends without any one company leading very far ahead. It is seldom, apparently, that one company in any given industry breaks away from the crowd and incorporates into its product the many features of design that have been used successfully in other industries. Possibly the highest type of all-around design for mechanical details is found in machine tools, the most general attention to finish of details in office machines, the best examples of ingenious mechanisms in packaging and canning machinery. But where will one find products that show throughout that the very latest developments in all factors—mechanisms, finishes, materials, have been incorporated from the experiences of all industries?

The work of the product engineer today is a broad-gaged one, and he has to draw his lessons from the experiences of engineers in other industries besides his own. The hardware designer can use the corrosion-resistant castings developed for chemical machinery, while the accelerating mechanism of a typewriter can be used on a grander scale in a large packaging machine. In some few industries, like the automotive, the engineers have shown more vision than in others, but even in these there are too often evidences of close copying from competitors and lack of individual striking out. The real product engineer must be aware of engineering advances in other fields and have the vision to adapt them to his own. His vision must be broad indeed.

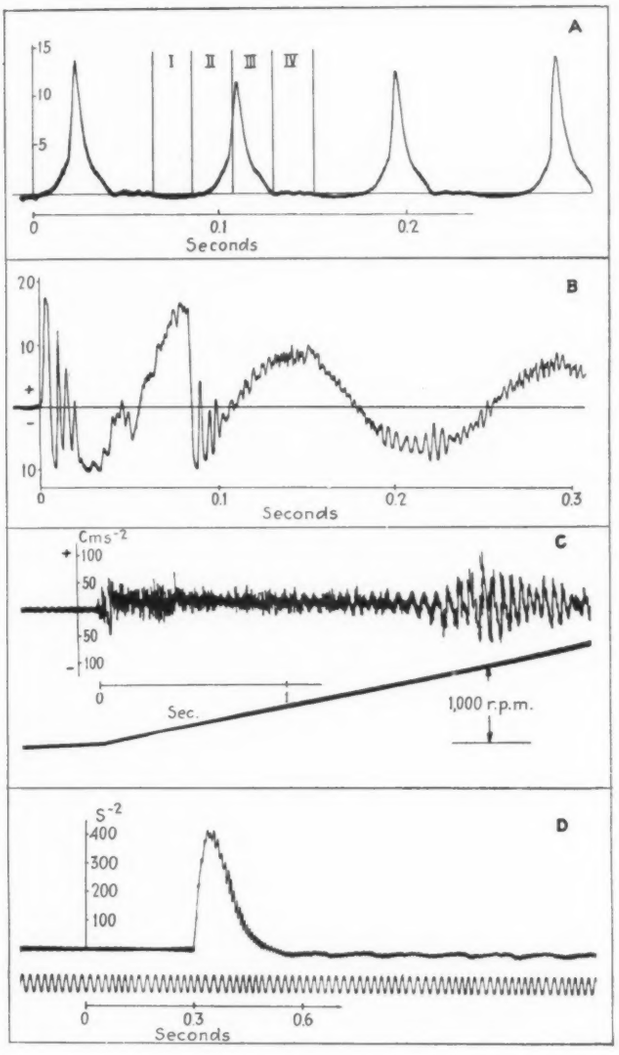
▼▼▼

Mechanical Forces Measured Electrically

By IRVING J. SAXL, Dr. Ing.
Consulting Engineer and Physicist

MECHANICAL means for the measurement of forces and pressures have the inherent weakness that friction and inertia forces in the measuring instrument give rise to errors. It has therefore been the aim of scientists to develop for such measurements electrical means that do not involve mechanical movements. The carbon pile has been one development, and has been used to a limited extent for the measurement of forces transmitted through the pile. In order to obtain an instrument that may be used for the measurement of pressures, stresses, and forces of all kinds, Doctors J. Kluge and H. E. Linckh, of the Physikalisch-Technische Reichsanstalt, Berlin, have recently perfected a device that makes use of electron action.

As this device works practically without inertia, it makes possible the recording of variations in forces or pressure action with an unusual degree of exactness and practically instantaneously. Furthermore, the method is easily adaptable to investigations of all kinds. The instrument is simple, does not require skilled operators, and can be applied to a machine in operation without appreciable interference. Only a small cartridge-like unit need be applied to the machine element to be investigated, while the actual measurement can be recorded in another room through electrical connections.



TYPICAL diagrams obtained by piezo-electric measurements
A—Indicator diagram of an 8 hp. internal combustion engine
B—Longitudinal vibrations in a steel wire suspended vertically from a piezo-crystal chamber and stressed by falling weights
C—Vibrations in the foundation of an a.c. motor
D—Acceleration of a d.c. motor

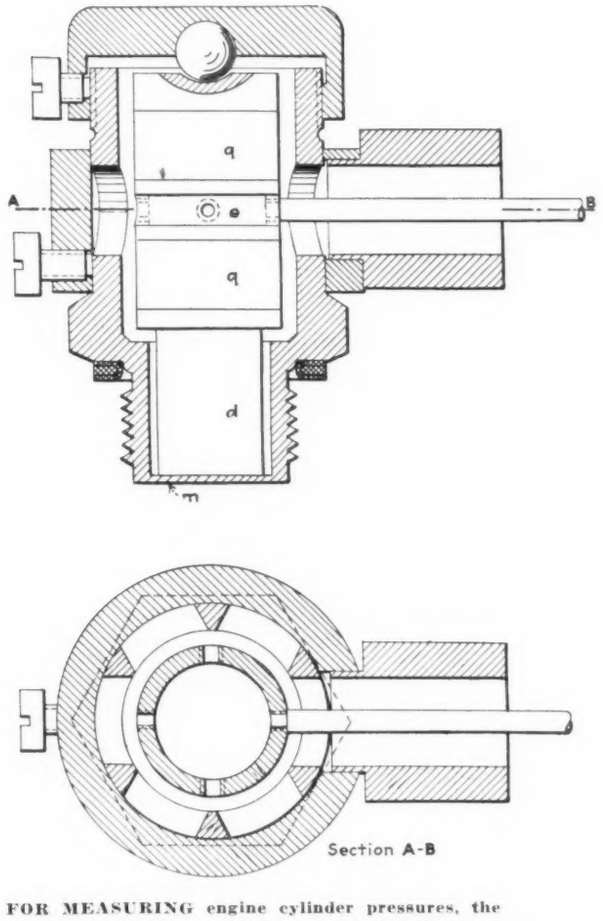
As shown in the accompanying illustration, the unit consists of two quartz crystals mounted in a chamber, the forces to be measured being applied upon the crystals through the membrane-like wall of the chamber. A ball bearing gives uniform distribution of the mechanical pressure upon both crystals. Two or more crystals are used in order to eliminate irregularities in the action caused by the influence of heat. Recent designs of the instrument incorporate as many as six crystals.

Operation of the instrument is based upon a physical phenomenon which has been known for a considerable time. If a crystal, for example a quartz crystal, is subjected to strain or pressure, a small electrical charge is produced at the opposite ends of the crystal. Normally, the electrical axis at the ends of which the voltage difference is

produced, coincides with the optical axis of the crystal. The electrical charges are very small and, with ordinary instruments, almost unnoticeable. They are, however, large enough to control an amplification system such as a tube voltmeter. Thus, the piezo-crystal, as it is called, transforms the mechanical forces into electrical charges, and these minute traces of electricity are amplified in the tube voltmeter and can be recorded easily. Any of the known recording devices for such purposes may be used, for example a string galvanometer or, for very high frequency, a cathode-ray oscillograph.

In the past, the piezo-electric properties of the crystals have been in common use, but for entirely different purposes. Madam Curie, for instance, had used piezo-electric crystals in special apparatus for the calibration and investigation of the ionization currents emitted by radioactive preparations. Today, in broadcasting, the crystal is used for the control of the generated high frequency.

Transmission of vibrations through foundations can readily be measured by placing a piezo-electric detector upon the foundation, thus measuring the oscillations impressed upon the foundation and



FOR MEASURING engine cylinder pressures, the piezo-crystals are mounted in a chamber that can be screwed into the cylinder like a spark plug

Exact determinations of important factors such as deflections in machine frames and elements, cutting pressures, forces exerted in punch and power presses, explosive actions in internal combustion engines, and frequencies and amplitudes of vibrations, have awaited the development of an inertia-free measuring instrument. The author, an authority on physics and engineering, describes the construction and operation of such a device, perfected by Doctors Kluge and Linckh of Berlin

the vibrations of the foundation. Herewith is given a table showing a comparison between the transmission of vibration through different materials as determined by piezo-crystal measurements, brass being taken as unity. In a similar manner, the piezo-electric crystal can be used for the study of any vibration problem.

Special chambers have been constructed for piezo-electric crystals, so that they can be screwed in like a spark plug in order to measure the pressures in internal combustion engines. On account of the absence of inertia and the instantaneous response of the crystal, power diagrams taken

Transmission of Vibrations Through Different Materials

Material	Brass	Lead	Wood	Cork
Vibration Index	1.00	0.98	0.70	0.29

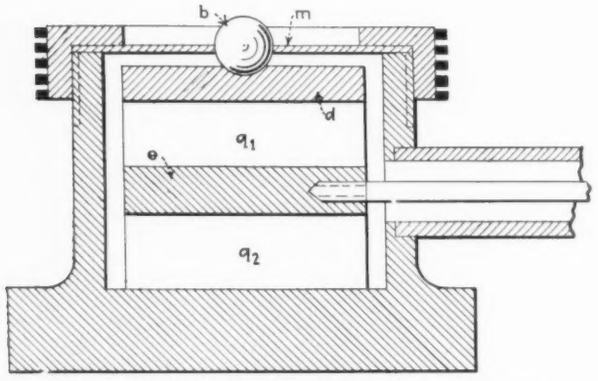
with this method make visible and enable one to measure all the small superimposed pressure waves emanating from the explosion. Thus, an accurate and complete study of the explosion action that takes place with different fuels in the combustion chamber of a gas engine can be made. Indicator diagrams of steam engines and compressors can be obtained in a similar manner. The great sensitivity and quick action make possible a more detailed and accurate study of valve actions and pressure changes inside the cylinder.

Effects of static or dynamic forces can be investigated equally well. The forces with which a rail is bent when a train is rolling over it can be measured with the aid of a special adapter which permits only a fraction of the force to be transmitted through the crystal chamber. Thus, although the crystal can withstand a pressure of only about 1,000 atmospheres, much higher forces

can be measured. The same holds true for loads on girders or machine frames.

Under ordinary circumstances, this crystal-dynamometer shows a sensitivity of about two hundredths of a pound. The amplification device is designed so that the indicating dial reads about half a milliampere for each pound of pressure applied to the quartz chamber. The relation between the pressure applied to the chamber and the electrical charge produced on the crystals is almost linear and hence the instrument can easily be checked by calibration.

Besides the measurement of forces acting on the elements of a machine, any vibrations within the machine can readily be measured with the piezo-electric vibrometer. Thus, the fracture of rapidly rotating or moving parts, as a result of vibratory stresses, can be prevented by the detection and subsequent elimination of the vibration. With this electric method vibrations can be recorded to a great degree of exactness whereas with any mechanical recording devices such vibrations would not be noticeable because of the natural inertia of mechanical instrument parts.



QUARTZ crystals mounted in chamber of piezo-electric measurements. q_1 and q_2 are the crystals, e is the electrode, m is a flexible membrane, and b is a steel ball

Other practical applications of piezo-crystal include the measurement of the pressure exerted in machine tools, and the resistance of hydroplane pontoons to impact when alighting on water.

In the study of membrane analogies as used in applied mechanics, the tension of the membrane can be measured with the piezo-electric instrument. A movement of only one three-thousandth of an inch can be recorded.

As force and mass action are fundamental in the design of all mechanical machinery, and because of the wide range of application of the piezo-electric methods, this new measuring device promises to become valuable for the investigation and development of all types of machinery.

The Head of the Table

By Paul B. Swinton

THE meeting was open for discussing the question "To whom is the chief engineer responsible?" Hotchkiss, of Harpers Specialties Company, had the floor.

"In our business the chief engineer is responsible to the vice-president in charge of sales. That's because the vice-president is in direct contact with customers and knows their wants."

"That may work in some concerns," spoke up Campbell, a chief engineer. "But in our business the success or failure of equipment depends on factors that cannot be analyzed by salesmen, or even by our customers. The engineering and production departments report to a vice-president in charge of those two divisions. This insures a close degree of cooperation."

"It seems to me that greatest progress can be made only when the engineering and development departments function under a separate vice-president or are responsible only to the president of the company," said another man. "The engineer is not hampered by pet ideas of impractical sales managers. Some sales managers force unworkable suggestions upon the engineer, and when the product fails they argue that the idea was correct but the engineering wrong."

"I often wonder," replied Hotchkiss, "how many of these 'unworkable' suggestions could be developed if there were real cooperation between sales and engineering."

"Gentlemen," said the speaker of the evening, a consulting engineer, "It is evident that every business requires its own peculiar organization structure. This will be determined not only by the nature of the business but largely by the individual abilities and personalities of the men heading the concern. When all is said and done, a business is solely to make money. This requires that the products be salable and economical to manufacture; hence there must be cooperation between engineering, sales, production, purchasing, and patent departments.

"The question is, to whom shall the engineer be responsible? Does not the answer to this question depend upon the relative aggressiveness and personalities of the men concerned? Is it not up to the engineer to put himself in the position wherein he will be the leader in product development, rather than a follower? Is it not true that the head of the table is where MacGregor sits, even if it be a round table?"

Volume, Weight, and Cost Chart

REFERENCE BOOK SHEET

REFERRING to the chart on the next page: for figuring weight and cost of round or hexagonal stock, the diameter is located on line *E*, the left side of which is graduated in rounds and the right side in hexagonal sections. The length of the piece, plus cut-off and end waste allowances, is located on line *G*. A straight line drawn between these two points locates the volume of the piece on line *F*. A straight line connecting this point and the kind of material used (line *A*) locates pounds per hundred pieces on line *D*. A straight line connecting this point with the cost per pound (left side of line *B*) locates the cost per hundred pieces.

When rectangular stock is used, the thickness is located on the right side of line *B* and the width on line *G*. A straight line connecting these two points locates the area in terms of round or "hex" bars, on line *E*. Connecting this point with the length of the piece (line *G*) locates the volume on line *F*. If it is necessary to know the area of the rectangle, the point so located on line *E* is connected by a straight line through 1 on line *B*. If it is necessary to use the 0.1 point on line *B* instead of 1, the answer must, of course, be divided by 10. Areas of rounds or hexagonals are similarly ascertained.

Submitted by A. D. McKenzie,
Chief Draftsman, Ohio Brass Company

Table of Standard Wire Gages

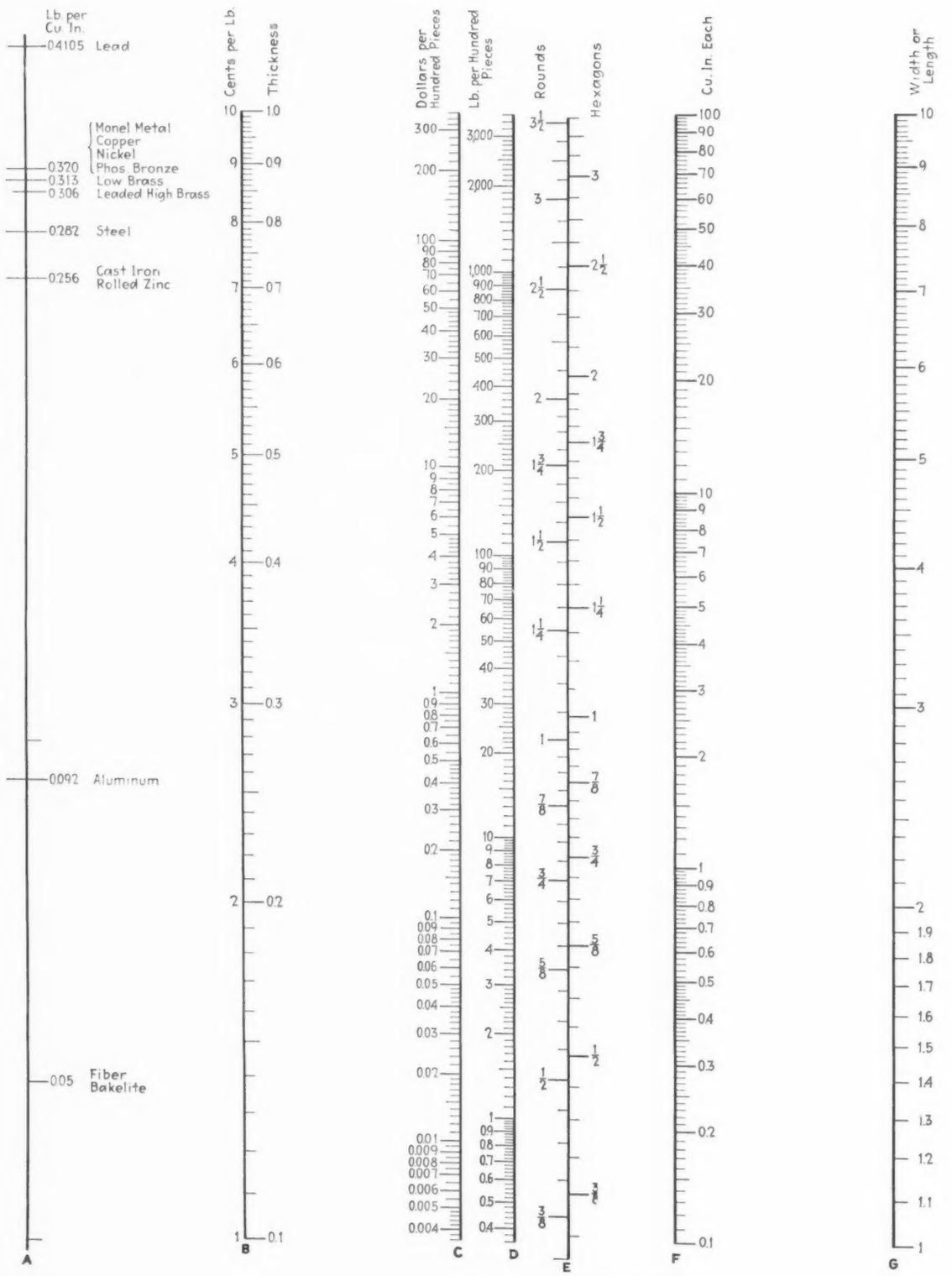
This table shows the standard wire gages and the names of major commodities for which each is used. To determine the gage used for any commodity, notice the number in parenthesis opposite the commodity named and find the gaged column below bearing the same number in parenthesis.

Aluminum (2) [Except Tubing (1)]
Bands (1)
Brass Tubing (¾" O.D. and Larger) (1)
Brass Tubing (Smaller than ¾" O.D.) (2)
Brass Sheets (2)
Brass Strips (2)
Brass Wire (2)
Copper Sheets (2)
Copper Wire (2)
Flat Wire (1)
Hoops (1)
Iron Wire (4)
Monel Metal Sheets (3)
Music Wire (5)
Nickel Sheets (3)
Nickel Silver Sheets (2)
Nickel Silver Wire (2)
Phosphor Bronze Strip (2)
Spring Steel (1)
Steel Plates (3)
Steel Sheets (3)
Steel Tubing, Seamless and Welded (1)
Steel Wire (4) [Exceptions: Music Wire (5), Armature Binding Wire (2), Flat Wire (1)]
Strip Steel (1)

Ga. No.	(1) Birmingham or Stubs'	(2) American or Brown & Sharpe	(3) U. S. Standard	(4) Washburn & Moen	(5) Music Wire (Std)
6/0	....	.5800	.4687	.4615	.004
5/0	....	.5165	.4375	.4305	.005
4/0	.454	.4600	.4062	.3938	.006
3/0	.425	.4096	.3750	.3625	.007
2/0	.380	.3648	.3437	.3310	.008
1/0	.340	.3249	.3125	.3065	.009
1	.300	.2893	.2812	.2830	.010
2	.284	.2576	.2656	.2625	.011
3	.259	.2294	.2500	.2437	.012
4	.238	.2043	.2343	.2253	.013
5	.220	.1819	.2187	.2070	.014
6	.203	.1620	.2031	.1920	.016
7	.180	.1443	.1876	.1770	.018
8	.165	.1285	.1718	.1620	.020
9	.148	.1144	.1562	.1483	.022
10	.134	.1019	.1406	.1350	.024
11	.120	.0907	.1250	.1205	.026
12	.109	.0808	.1093	.1055	.029
13	.095	.0719	.0937	.0915	.031
14	.083	.0640	.0781	.0800	.033
15	.072	.0570	.0703	.0720	.035
16	.065	.0508	.0625	.0625	.037
17	.058	.0452	.0562	.0540	.039
18	.049	.0403	.0500	.0475	.041
19	.042	.0359	.0437	.0410	.043
20	.035	.0319	.0375	.0348	.045
21	.032	.0284	.0343	.0317	.047
22	.028	.0253	.0312	.0286	.049
23	.025	.0225	.0281	.0258	.051
24	.022	.0201	.0250	.0230	.055
25	.020	.0179	.0218	.0204	.059
26	.018	.0159	.0187	.0181	.063
27	.016	.0142	.0171	.0173	.067
28	.014	.0126	.0156	.0162	.071
29	.013	.0112	.0140	.0150	.075
30	.012	.0100	.0125	.0140	.080
31	.010	.0089	.0109	.0132	.085
32	.009	.0079	.0101	.0128	.090
33	.008	.0071	.0093	.0118	.095
34	.007	.0063	.0085	.0104	.100
35	.005	.0056	.0078	.0095	.106
36	.004	.0050	.0070	.0090	.112
37	....	.0044	.0066	.0085	.118
38	....	.0039	.0062	.0080	.124

Volume, Weight, and Cost Chart

REFERENCE BOOK SHEET



{Instructions for use of chart on preceding page}

✦ COMMENT ✦ AND SUGGESTION

Calculation of Epicyclic Gear Trains

By John E. Haig
Ajax Electric Company, Inc.

FOLLOWING is a novel application of epicyclic gearing which I developed several years ago. The motion was born of the necessity for giving a reciprocating travel of 28 in. to a rolling carriage mounted on a machine frame with but 18 in. between the side members. Obviously, a crank with a throw of 14 in. could not be mounted between 18-in. frames and, for reasons not pertinent to this discussion, a motion such as the multiplying lever used in shapers was not applicable. Doubtless some other and possibly simpler motion could have been used, but the novelty of the idea consists in the application of epicyclic gearing to a "folding" crank.

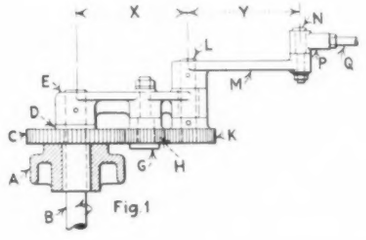


Fig. 1

Fig. 2-0 Deg.

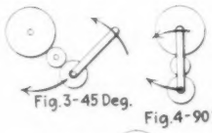


Fig. 3-45 Deg.

Fig. 4-90 Deg.

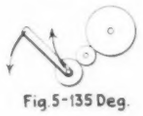


Fig. 5-135 Deg.

Fig. 6-180 Deg.

In Fig. 1, *A* is a cross-member or girt of the machine frame; *C* is a gear secured to the girt by two body-bound screws (not shown); *D* is a bronze head-bushing pressed into the gear *C* and girt *A* acting as a bearing for the shaft *B* and as a dowel between the girt and gear; *B* is a driven shaft; *E* is a lever pinned to shaft *B* and carrying a stud *G* on which the idler gear *H* rotates and having at its extremity a bushed hole in which the stub shaft *L* rotates. The gear *K* and the lever *M* are pinned to opposite ends of shaft *L*. The rod-end *P* is free to turn on the stud *N* and is tapped for adjustment of the connecting rod *Q*. This connecting rod is connected at its other end by a clevis and pin to the carriage.

When the shaft *B* rotates in a clock-wise direction (viewed from above) carrying with it the lever *E*, the gear *H* rotates on pin *G* in a clock-wise direction, causing gear K, and with it lever *M*, to rotate in a counter clock-wire direction. If gear *C* is made twice the diameter of *K* (gear *H* being an idler and its diameter unimportant from a theoretical standpoint), when the shaft *B* has made one revolution, the gear *K* will have made two revolutions about its own center *but in the opposite direction*. This has the effect of "folding" the crank upon itself and at 90 deg. (see Fig. 4) and 270 deg. the lever *M* will be over lever E and at 0 deg. and 180 deg. it will be extended. Now if the center to center distance of levers *E* and *M* are made equal, that is, distance *x* made equal to *y* (Fig. 1), the path described by the center of the stud *N* will be a straight line. The mathematical proof of this is simple, therefore is not given.

In Figs. 2 to 6 is shown the relation of position of the levers at 0, 45, 90, 135, and 180 deg. For the sake of simplicity such details as provision for lubrication and the securing of studs *G* and *N* are not shown.

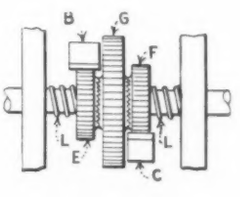
■

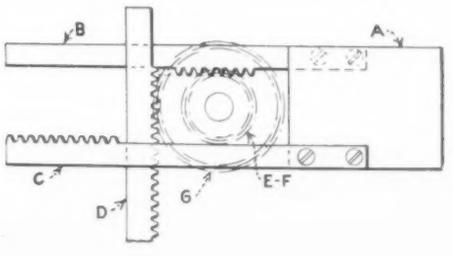
Reciprocating Mechanism

By John Dan
Mechanical Engineer

IN the development of a special automatic machine, it was found necessary to convert the uni-directional motion on the back stroke of a plunger into a reciprocating motion. Thus, referring to the accompanying illustration, it was required that while the plunger *A* is making its return stroke, the element *D* shall be raised and then brought down to its initial position. The element *D* was required to remain stationary during the opposite stroke of the plunger *A*.

Space limitations did not permit the use of cams and linkages. Therefore the mechanism shown was developed. The element *D* is actuated by the gear *G* which in turn is driven by the loosely mounted gears *E* and *F* through the ratchet clutches. The springs *L*, hold the ratchet clutches in engagement when the rotation is in one direction but not when the rotation is in the opposite direction. As the gears *E* and *F* engage with the racks *B* and *C* respectively, it is evident that the rotation of *E* and *F* will be in opposite directions. Further details of the operation of this mechanism are evident from the figures in the illustration.





■

Who Gets the Order?

By E. N. Jeneer

[We publish the following communication without comment, leaving that up to our readers. For obvious reasons, the author's real name is being withheld.]

SEVERAL weeks ago, I sent an inquiry to several manufacturers of special equipment. All of the letters were identical, and set forth two different ways of possible operation of the units with respect to the machine to which they were to be applied. In each case the manufacturer was requested to recommend the operating pressure, speed, and horse-

power required to drive the units. The following replies were received from two of the manufacturers. For obvious reasons, the names of the companies are omitted and only such portions of their letters are quoted as may be of interest. Company *A* wrote:

"Gentlemen:

Thanks for your inquiry..... However, from the information given, we are unable to make any definite recommendations.

Inclosed is a copy of our catalog. .....We trust it will be of assistance to you in selecting the proper unit. We hope you will be in a position to select what you consider the proper unit.

Very truly yours,
Sales Department."

Now, behold the reply received from manufacturer *B*. Here it is:

"Gentlemen:

We have your letter....to which we have given some consideration.

There are one or two points on which we have not sufficient information, but as a preliminary recommendation we would suggest that you use..... This assumes that the unit will be used intermittently, and if this be true, operating pressures up to 1,000 lb. per sq.in. can satisfactorily be used.

On this assumption, our X231 unit running at 1,200 r.p.m. and requiring 12 hp. can be used. You mention two different ways of operation. Are these optional constructions or will both be used on the same machine? If so, and based on your second proposal, we would recommend.....

Prices on this equipment are as follows:.....

We will be pleased to have the additional information requested, and to revise our recommendations if necessary.

Very truly yours,
....."

Now, I wonder who is going to get that order. Personally, my feeling is that company *A* does not know the product it is selling. At least it sounds that way. What we need is more engineers and fewer "salesmen" in the sales department of companies manufacturing the products that engineers buy.

■

Assembly Drawings

By J. A. Covington

FREQUENTLY the original layout drawing is not suitable for tracing off the desired assembly drawing. If the sub-assembly and detail drawings have already been made, it is a simple matter to use these to obtain the assembly drawings.

Usually the sub-assembly drawings and large details will be to different scales, but by having the drawings photostated to the proper reduction or scale, prints to a uniform scale will be obtained. Negative photostat prints, white lines on a black background, are satisfactory, the lines showing clearly through the tracing cloth. Having obtained the photostats, they are slipped under the tracing cloth, and their center lines are made to coincide with center lines previously established on the tracing cloth, and the parts traced with ink. In this way, the final assembly drawing may be built up directly from the sub-assemblies and details.

■

STOP... LOOK... LISTEN...

•

. . . WEIGHT OR WEAR? . . .

CAST-IRON pistons are not going out by any means. In fact, in some places there has been a turnabout and readoption of close-grained, well-cast iron pistons. Properly ribbed for strength, warpage, and light weight, cast-iron pistons are being used effectively.

•

. . . LITTLE THINGS HELP SALES . . .

LEONARD refrigerator has adopted a foot-pedal door opener. Simple as the discovery of America—a device that has been known for generations but apparently has never been generally applied to refrigerators. Here are some designers who didn't overlook the little things in mastering the big problems.

•

. . . CHEAPER FOODS TOO? . . .

AT the convention of the American Society of Agricultural Engineers it was shown that machinery is having a tremendous influence on the farm. Equipment now includes air-conditioning apparatus for cow barns, electric heating pads for hot beds, mechanized sprays, and feed-processing machines. The rapid progress of farm mechanization in the next few years will open a widening field of thought for the product development engineer.

•

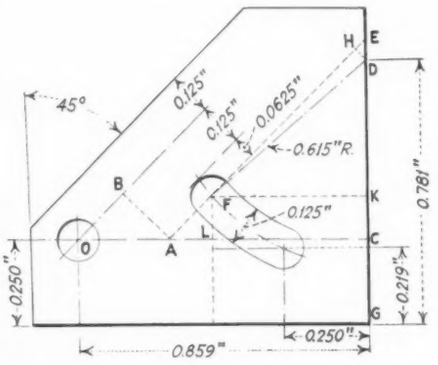
. . . CHECK THE SPEED . . .

FUEL meters installed on trucks and buses are claimed to show results in gasoline savings as high as 25 per cent by showing up poor driving or bad conditions in the engine. Why not have meter gages on the panel board

A Few More Answers

FOLLOWING are some additional solutions to the problem "What is the Answer?" that appeared in the October number of *Product Engineering* relative to the calculation of dimensions.

Solution by Karl A. Eckhardt
Engineer, Lamson & Sessions Company



Before proceeding with the solution, I wish to point out a discrepancy. The radius 0.615 in. is given in the drawing accompanying the problem as that of the inner edge of the radial slot. This is in error, and it should be shown as the radius of the center line of the slot. Adopting the correction and referring to the accompanying figure, we have:

$$BA = .125 + \frac{0.125}{2} = 0.1875$$

$$OA = \frac{BA}{\sin 45} = \frac{0.1875}{0.70711} = 0.26516$$

But $CO = 0.859$

Therefore

$CA = 0.859 - 0.26516 = 0.59384$

and

$EC = AC \times \tan 45 = 0.59384 \times 1 = 0.59384$

But

$DC = DG - CG = 0.781 - 0.219 = 0.562$

Hence

$ED = EC - DC = 0.59384 - 0.562 = 0.03184$

$DF = 0.615$ and $\angle FED = 45$ deg. (by construction)

In $\triangle EHD$, EH and HD are perpendicular and equal, by construction

Then

$EH = HD = 0.03184 \times \sin 45 \text{ deg.} = 0.03184 \times 0.70711 = 0.02251$

And in

$\triangle DHF$, $HF = \sqrt{DF^2 - HD^2} = \sqrt{0.615^2 - 0.02251^2} = \sqrt{0.377718} = 0.61458$

Hence

$FE = FH + HE = 0.61458 + 0.02251 = 0.63709$

In $\triangle EFK$, $EK = FK = EF \times \cos 45 \text{ deg.} = 0.63709 \times 0.70711 = 0.45049$

But

$DK = EK - ED = 0.45049 - 0.03184 = 0.41865$

And

$KG = DG - EK = 0.781 - 0.41865 = 0.36235$

Dimension X of original drawing $= FK = 0.45049$ in.

And $Y = KG = 0.36235$ in.

This problem furnishes an excellent demonstration of the type in which the result is called for with accuracy to the fourth decimal place, but the information given is correct only to the third decimal point. This is, of course, practically impossible though it is often mistakenly required. It should be considered merely as a coincidence if the final result checks in such a case.

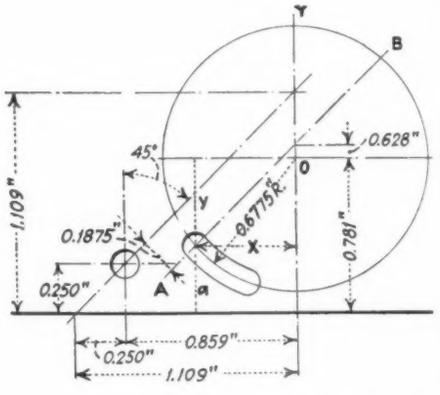
In this problem it is evident that the dimensions given should have been as follows:

0.781 is intended for 0.78125 or $\frac{25}{32}$
0.859 is intended for 0.859375 or $\frac{55}{64}$
0.219 is intended for 0.21875 or $\frac{7}{32}$

If we now figure the same problem in the same way but with these dimensions substituted for those given, we have not only accuracy to the fourth place but the results will check exactly. With these figures the result will be the same, namely:

$X = 0.45049$ in.
$Y = 0.36235$ in.

SOLUTION BY C. A. WIKEN
Greenlee Bros. & Company



Referring to the accompanying figures, consider the point O as the origin of the X and Y axis. The line AB passing through the point in question is 0.1875 in. from the given line that passes through the 0.120 in. reamed hole. Both lines have a slope of 45 deg., and since line AB crosses the X and Y axis as shown, its equation is:

$$x - y + 0.0628 = 0$$

The equation of the circle passing through this same point is

$$x^2 + y^2 = (0.6775)^2$$

Solving the first equation for y and substituting its value in the second equation we obtain:

$$x^2 + 0.628x - 0.22753 = 0$$

The solution of this quadratic equation gives

$X = -0.50943$ in. and $+0.44663$ in.

Since the circle and line AB intersect again in the opposite quadrant, it is obvious that these two values of x satisfy both x and y in the figure, for if 0.50943 is substituted into the second equation, y would equal 0.44663. Hence the answers are

$x = 0.50943$ and
$a = 0.781 - 0.44663 = 0.33437$

Answers were received also from the following:

J. A. PETRONIA

Using the dimension of the radial slot as 0.5525 instead of 0.615 as given, we get the following values:

$x = 0.4651$
$y = 0.3787$

G. V. CRANER
Sparks-Withington Company

Using the radius of the center line of the slot as 0.615 in.:

$x = 0.46515$
$y = 0.37869$

This solution was calculated entirely using the old familiar mathematical relationship of the squares of the sides of a right angle triangle.

JOHN S. PAGANELLI

Using the radius of the center line of the slot as being 0.615 in.:

$x = 0.46514$
$y = 0.37869$

WILLIAM R. KOMAREK

Using the radius to the center line of the slot as 0.615 in.:

$x = 0.4651$
$y = 0.3788$

W. W. JOHNSON
Trundle Engineering Company

Using the radius to the center line of the slot as 0.615 in.:

$x = 0.46516$
$y = 0.15969$

of passenger automobiles? They would be a check on gasoline consumption, but better still, they might serve to show up how costly 60-mile speeding is in a 30-mile car.

•

. . . MORE VISION . . .

RALPH E. FLANDERS, manager of the Jones & Lamson Machine Company, and writer on economic issues, in naming the qualities of character needed in the four periods of the economic cycle gives "vision and imagination as the vital qualities for depression periods. There is no place in the industrial organization where "vision and imagination" can be shown to better advantage than in the engineering department in the development of new and improved products.

•

. . . HARD FACINGS . . .

SOME time ago there was mentioned in these columns the use of Stellite as a valve seat facing in a homogenizing machine in the food industry. Now comes news that the new Yellow Coach engine has valve seats of Stellite bonded to a base of mild steel, the Stellite to give high wear resistance and the softer metal to absorb the shock. It is claimed that the hard facings entirely eliminate regrinding of valve seats.

•

. . . DRY CLEANING AT HOME . . .

DRY cleaners continue to keep up prices, and today's thrifty housewife is seeking a good home dry-cleaning unit. A hand-operated unit and another combined with a washer are available, both susceptible of further development. Might this item not prove a profitable one for electrical manufacturers? Fireproof dry-cleaning fluids are available.

•

. . . MORE AUTOMATICITY . . .

PACKAGED goods are getting more popular every day, and all sorts of industries are calling on the engineer to design automatic machines for weighing out and wrapping such varied products as butter, ice cream, candy, bolts and nuts. The food industries particularly offer opportunities for clever designs in wrapping and packaging machines.

•

. . . WEAR RESISTANCE . . .

AN article in *Engineering and Mining Journal* describes how pipe lined with rubber vulcanized to the inside gave more than a hundred times the life of plain steel pipe when subjected to the abrasion of sand passing through it continnously. It is an illustration of a principle sometimes forgotten—that metal wearing surfaces lined with a resilient material are often better adapted for wear resistance than are very hard surfaces.

WHAT'S GOING ON—

A.S.M.E. Meeting Program Includes Design Subjects

Other Engineering Meetings

A number of papers on design and engineering subjects are included in the program of the annual meeting of the American Society of Mechanical Engineers to be held in the Engineering Societies Bldg., New York City, Nov. 30–Dec. 5. GEORGE B. KARELITZ is cooperating with A. G. SOLAKIAN in discussing a photo-elastic study of shearing stresses in keys and keyways. J. ORMONDROYD and T. C. KUCHLER will discuss the design of spring gears for exhaust turbine installation, while N. H. PREBLE will speak on the design of a floating drive for conveyors. S. TIMOSHENKO will report on the results of a study of stresses, in railroad tracks, and O. G. TIETJENS will discuss recent developments in cutting air-resistance of high-speed trains and suburban cars. Several cars of this type are now being manufactured, and streamlined railway cars are already in use in Europe, so this subject has much present importance. Another subject many times discussed in *Product Engineering* is that of correlation of design and engineering departments with other elements of a company. ALEX TAUB will speak on correlating design and the foundry, while CARL L. BAUSCH will discuss the coordination of research, sales and production. A number of papers will also be presented on lubrication and oil-film problems.

How safe is a weld, and how can its strength be evaluated? These questions of several years ago are now being answered by a wide variety of non-destructive tests. At the recent meeting of the International Acetylene Association in Chicago there was a demonstration before an audience of all known weld testing methods, including visual inspection, the hammer and anvil nick break tests with fracture examination, the free-bend test to determine weld ductility by direct measurement of the elongation of its outside fibers after bending, tension tests in a portable hydraulic pulling machine, Brinell and Rockwell hardness tests, the A.S.M.E. specific gravity test for unfired pressure vessel welding, the stethoscope test in which a stethoscope is used to detect faulty "ring" in the sound of a hammer tap on the weld, compression tests, tapered drift tests, hydrostatic tests, and slides illustrating X- and gamma-ray tests.

That machine tool builders are making safety a matter of forethought in machine design rather than one of afterthought is the opinion of S. Morgan, director of education, Buick Motor Co., expressed at the recent meeting of the National Safety Council. This factor is considered on the drawing before the machine is built. Use of hydraulic feeds has eliminated gears and levers that have been the cause of some shop accidents.

The Institute of Metals (Great Britain) has just issued its full program of meetings for the winter session both of the parent institute and of its six local sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea.

Among the subjects dealt with are mechanical testing of metals, electric welding of non-ferrous alloys, the extrusion of metals, recent advances in rolling plate, X-ray examination of alloys, protective coatings on metals, and notes on condenser tubes. Copies of the program can be obtained on application to the secretary, G. Shaw Scott, 36 Victoria St., Westminster, London, S.W.1, England.

The die casting industry, which has grown from nothing to annual sales of $25,000,000 in less than 25 years, is now to inaugurate a development program under the American Die Casting Institute. A committee, consisting of W. G. NEWTON, president of the Newton Die Casting Corp., New Haven, Conn., and president of the Institute; CHARLES R. MURRAY, president of Barnhart Brothers & Spindler, a former president of the Institute; and H. R. RINEHART of Philadelphia, the Institute's secretary, conferred recently with Secretary of Commerce LAMONT regarding the problems of their industry and the possibility of inaugurating a development program nationwide in scope.

To provide training in freehand industrial sketching, the University of Wisconsin Extension Division is offering a new course of 16 assignments, taught by the home-study method for students anywhere. It introduces the necessary procedure for making engineering sketches.

Dr. H. C. Parmelee Elected McGraw-Hill Vice-President

DR. H. C. PARMELEE, editorial director of the McGraw-Hill Publishing Co., Publisher of *Product Engineering,* has been elected a vice-president. The election follows Dr. Parmelee's successful administration of his duties as editorial director since his appointment three years ago.

Dr. Parmelee has been editorial director of the McGraw-Hill publications since 1928. Prior to that he was editor of *Chemical and Metallurgical Engineering,* from 1919 to 1928. He was graduated from the University of Nebraska in 1897. For some years he was employed as a chemist around Denver, establishing his own consulting office there in 1902. He entered editorial work in 1905, and joined *Chemical and Metallurgical Engineering* in 1910 as western editor. He was elected president of the Colorado School of Mines in 1916, and returned to McGraw-Hill in 1917.

©Blank & Stoller

News of the Metal Markets

COPPER producers have come to a partial agreement, and the conferees at the recent meeting of world copper men agreed to limit all countries to a production of 55,000 tons a month. The marketing program, however, is indefinite, and may be set by the actions of the small producers. Copper prices held at 7c., with increased sales late in October and in early November, but after the conference the price dropped to $6\frac{3}{4}$c. delivered in Connnecticut.

PLATINUM producers of the world entered an accord on Oct. 22, and a new English company, Consolidated Platinums, Ltd., will buy and resell the major portion of the world's output of this metal. The market price, which is $40 per oz., is expected to remain stable.

LEAD markets were active for a period of about three weeks and then subsided, according to *Metal and Mineral Markets*. Business was on a small-lot basis during the middle of November, and the price remained at 3.90c. St. Louis. Lead stocks increased in October.

TIN prices have lately been nominal, and the offerings of tin at 23c. by importers have been accepted rather than bidding by consumers. Further curtailment of production is being considered.

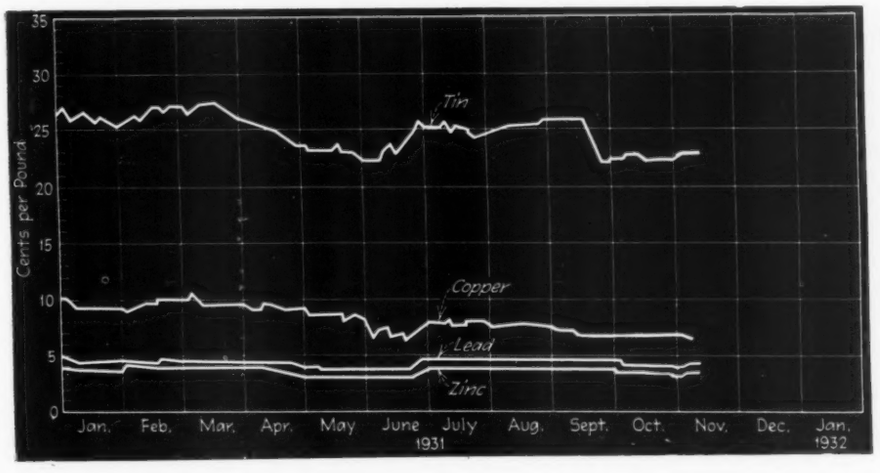
ZINC business is being done (Nov. 23) on a basis of 3.30c. per pound St. Louis, with a rather quiet market. The zinc stocks of the world increased during October, and a revised program of the producers calls for a curtailment down to 50 per cent of capacity.

SCRAP metal prices have been affected by the news of curtailment of production of raw metals. Brass ingot makers have booked considerable business. Secondary aluminum showed an improved demand with prices on 98-99 per cent ingot firm at 17 to 18c. delivered.

STEEL ingot production increased slightly during the middle of November. Sheet steel mills are booking more business, according to the *Daily Metal Trade*, and the automobile demand for steel is expected to gain. Steel prices have held steady since early September.

Machined Finishes To Be Standardized

Machined finishes bid fair to become prominent shortly in the minds of engineers and designers, the A.S.M.E. just having formed a committee to investigate the subject. About a year ago, R. E. W. HARRISON, engineering director of Cincinnati Grinders Incorporated, presented an introductory paper on this subject before the A.S.M.E., providing an audic method of maintaining surface quality standards and including an appendix by DR. C. B. SAWYER discussing microscopical examination of surface cross-sections. Resulting discussion, particularly by grinder makers, showed immediate need for some standard system of designating and evaluating these surfaces, and has resulted in the formation of the special committee acting under ASA procedure. Included in its personnel are MAJOR WILLIAM B. HARDIGG of the U. S. War Department (chairman), FRANK R. HENRY, F. O. HOAGLAND, C. B. LEPAGE, and C. B. VEAL. Major Hardigg is a leader in standards coordination work. One suggestion thus far advanced is that of R. C. DEALE that three standards, rough, medium, and fine, be set up in the individual plant for each type of machinery operation, and work be made to the required standard. Chief merit of this proposal is the suggestion, after the European plan, that simple triangles, circles, or other marks be used to designate finishes on drawings instead of the conventional *f* mark. These are put on as is the present designation, but one for rough, two for medium, three for fine, indicate exact finish desired, thus avoiding the necessity of lettering in instructions.



Meetings

American Society of Mechanical Engineers—Annual meeting, Engineering Societies Bldg., 29 West 39th St., New York, N. Y., Nov. 30-Dec. 5. Calvin W. Rice, secretary, above address.

American Railway Development Association—Semi-annual meeting, Hotel Sherman, Chicago, Ill., Dec. 3-4. Arthur W. Large, secretary, 721 LaSalle St., Chicago, Ill.

Motor & Equipment Association — Annual convention and second joint trade show of M.E.A. and N.S.P.A., Atlantic City, N. J., Dec. 7-12.

Seventh Annual Conference on Welding, to be held by the Engineering Extension Department of Purdue University at Lafayette, Ind., Dec., 10-11. Professor in charge W. A. Knapp, Engineering Extension Department, Purdue University, Lafayette, Ind.

Steel Founders Society of America—December meeting, William Penn Hotel, Pittsburgh, Pa., Dec. 10. G. P. Rogers, managing director, 932 Graybar Bldg., New York, N. Y.

American Road Builders Association—Annual meeting and exposition, Detroit Airport, Jan. 9-15. Charles M. Upham, secretary, 938 National Press Bldg., Washington, D. C.

National Automobile Show—New York, Grand Central Palace, Jan. 9-16; Chicago, Coliseum, Jan. 30-Feb. 6.

Steel Founder's Society of America, Inc.—Annual meeting, Chicago, Ill., Jan. 21, 1932. G. P. Rogers, managing director, 932 Graybar Bldg., New York City.

National Association of Engine & Boat Manufacturers—Motorboat and marine engine show, Grand Central Palace, New York City, Jan. 22-30, 1931. Henry R. Sutphen, president.

Society of Automotive Engineers—Annual meeting, Book-Cadillac Hotel, Detroit, Mich., Jan. 25-29. John A. C. Warner, secretary, 29 West 39th St., New York.

American Institute of Electrical Engineers—Annual Winter meeting, Engineering Societies Bldg., New York, N. Y., Jan. 25-29. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

Second International Heating & Ventilating Exposition—Sponsored by American Society of Heating & Ventilating Engineers, in Grand Central Palace, New York City, Jan. 25-29. Charles F. Roth, manager, Grand Central Palace, New York, N. Y.

American Society of Refrigerating Engineers. — Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

Southwest Road Show & School—Seventh annual, Wichita, Kan., Feb. 23-26, 1932. Including exhibits of road machinery and equipment. Inquire Southwest Road Show & School, Wichita, Jan.

American Management Association—Packaging, packing, and shipping exposition, Palmer House, Chicago, Ill., Mar. 7-12, 1932. W. J. Donald, managing director, Room 602, 225 West 64th St., New York, N. Y.

IN THE SPOTLIGHT—

MAURICE L. KERR, formerly chief engineer of the Brockway Motor Truck Corp., Cortland, N. Y., now holds a similar position with the Indiana Truck Corp., Marion, Ind.

GREGORY J. COMSTOCK, director of research, Firth-Sterling Steel Co., McKeesport, Pa., presented a talk before the New Jersey Chapter, A.S.S.T., Nov. 4 on the manufacture of cemented hard carbide materials.

H. S. COCKLIN, formerly chief engineer of the Dornier Co. of America, New York City, has joined the General Aviation Mfg. Corp., Dundalk, Md.

FREDERICK A. BROOKS, formerly assistant engineer with the Byron Jackson Co., Berkeley, Calif., pump manufacturer, has joined the staff of the University of California as associate engineer in the agricultural engineering division at the university farm at Davis, Calif. He is engaged in research work on farm machinery.

RADFORD J. BERKY, formerly a draftsman for Chance Vought Corp., East Hartford, Conn., now holds a similar position with the Curtiss Aeroplane & Motor Co., Buffalo, N. Y.

CONRAD M. LAUER, president of the Philadelphia Gas Works, has been elected president of the American Society of Mechanical Engineers, and will be installed in that office during the annual meeting in New York, Nov. 30-Dec. 3. His nomination, practically equivalent to election, was announced in *Product Engineering*, in June. Other officers include: vice-presidents, ROBERT M. GATES, vice-president of the Superheater Co., CHARLES M. ALLEN, professor of hydraulic engineering of Worcester Polytechnic Institute, FRED H. DORNER, mechanical engineer, WILLIAM B. GREGORY, professor of experimental engineering of Tulane University.

ROBERT M. GAYLORD, president of the Ingersoll Milling Machine Co., Rockford, Ill., has been elected president of the National Machine Tool Builders' Association. Other officers include: 1st vice-president CLAYTON R. BURT, president and general manager, Pratt & Whitney Co.; 2nd vice-president, H. S. BEAL, assistant general manager, Jones & Lamson Machine Co.; and treasurer G. E. RANDLES, president, Foote-Burt Co.

ARTHUR C. BATES, formerly research assistant at the engineering experiment station, Purdue University, has resigned to become instructor in mechanical engineering at the Towne Scientific School, University of Pennsylvania, Philadelphia.

RICHARD COULSON, specialist in front-end drives and closely associated with the development of the compound roller chain now used for this work in Europe, has joined the Alfred Appleby Chain Co., Ltd., Birmingham, England, to have charge of all matters relating to automobile-chain applications.

W. CHAPIN CONDIT, until recently research engineer for the Sun Oil Co., Marcus Hook, Pa., has been transferred to the company's sales department in New York City.

JEROME M. COOK, formerly research engineer for the Hercules Motor Corp., Canton, Ohio, has become assistant superintendent of the experimental department, Oakland Motor Car Co., Pontiac, Mich.

ROBERT Y. COPELAND, formerly director of planning and engineering for the Dominion Rubber Co., Ltd., Montreal, has been transferred to the company's Kitchener, Ont., plant.

Maurice Kerr

●

Conrad Lauer

●

Robert Gaylord

●

CHARLES H. CROCKETT, formerly engaged in special research, design and patent engineering work for the Thos. J. Corcoran Lamp Co., Cincinnati, has organized C. W. Crockett & Sons, Troy, N. Y., with his father, C. W. CROCKETT, professor of mathematics and astronomy at Rensselaer Polytechnic Institute. They will develop a spring-suspension system for a light car and also carry on some head-lamp work.

HARRY J. HATER, vice-president and general manager of Aluminum Industries, Inc., has been appointed a member of the Manufacturers' Divisional Committee of the National Standard Parts Association, to succeed F. J. GLENNON, general sales manager of Aluminum Industries, Inc., who died recently.

D. W. DEAN, general engineer of the steel mill engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., addressed the Philadelphia Section of the Association of Iron & Steel Electrical Engineers recently, on "Application of Non-Radio Vacuum Tubes in the Steel Industry."

A. L. DELEEUW, consulting engineer of Plainfield, N. J., spoke on "Physical Properties of Steel Relative to Design," at the first fall meeting of the Hartford Chapter, A.S.S.T. Mr. DeLeeuw called attention to the lack of metallurgical data which the designer can use directly in his daily problems. To determine the applicability of a newly advertised material he must take the static tensile properties given by the manufacturer and by means of empirical formulas, which may not be accurate for the material, perform numerous calculations to convert the data to the form which he requires. Steel compositions without number are offered but no guidance is given to the designer regarding the proper selection for his particular attention. Dr. DeLeeuw did not put the entire burden upon the metallurgist, but said that some means of better cooperation between designing engineer and metallurgist must be found if the advantages of metallurgical improvements are to be fully used. Other speakers of the evening included president-elect A. H. D'ARCAMBAL and WILLIAM EISENMAN, national secretary.

HENRY J. EDLING, formerly die-designing engineer and checker, Fisher Body Corp., Detroit, Mich., has become president of the Peninsular Engineering Co., Inc., also of Detroit.

GEORGE B. FULLER, formerly aeronautic engineer with the Walker M. Murphy Co., Pasadena, Calif., has become aeronautic engineer at the Hancock Foundation College of Aeronautics, Santa Maria, Calif.

ERIC GEERTZ, formerly mechanical engineer with the Link Belt Co., Indianapolis, has become chief engineer of the Barber Greene Co., Aurora, Ill.

ALBERT H. GILBERT, formerly in the tractor department of the Rock Island Plow Co., Rock Island, Ill., is now working independently as a tractor-designing engineer.

EDWIN H. GODFREY has resigned as chief engineer of the Glenn L. Martin Motor Co., Baltimore, Md.

JOHN J. GRABFIELD, formerly test engineer for the Hudson Motor Car Co., Detroit, has organized a firm under the name John J. Grabfield & Associates, of Detroit, to engage in automotive and aeronautic engineering.

MARK HARRIS, formerly manufacturing research engineer for the H. H. Franklin Mfg. Co., Syracuse, N. Y., has been appointed chief engineer of the Gabriel Co., Cleveland.

E. H. KIMBALL, formerly mechanical engineer for the John Deere Tractor Co., Waterloo, Iowa, has become director of industrial education at West High School there.

J. M. KLEMENTS, formerly body-layout draftsman with the Pierce-Arrow Motor Car Co., Buffalo, N. Y., has accepted a similar position with the Chrysler Motor Car Co., Detroit.

W. LAURENCE LEPAGE, formerly chief engineer, Kellett Aircraft Corp., Philadelphia, Pa., has been elected vice-president in charge of engineering.

HOWARD W. LINKERT, formerly chief engineer for the Wheeler-Schebler Carburetor Co., Indianapolis, Ind., has become president of the Langsenkamp-Linkert Carburetor Co., Inc., also of that city.

DR. ELIHU THOMSON, director of research of the Thomson Laboratories, General Electric Co., and PROF. DUGALD C. JACKSON, head of the electrical engineering department of the Mass. Institute of Technology, spoke in observance of the Michael Faraday Centenary at the Engineering Societies Bldg., 29 W. 39th St., New York City, recently.

M. W. MCCONKEY, vice-president of the Bendix Brake Co., South Bend, Ind., has become a vice-president of the Bendix Research Corp., formed recently by the Bendix Aviation Corp., and the Standard Oil Co. of Indiana to manufacture and market grease fittings. A. Y. DODGE, general manager of the Lubrication Corp., is also executive engineer in South Bend of the Bendix Research Corp.

NORMAN N. TILLEY, for two years chief engineer of the Kinner Airplane & Motor Corp., Glendale, Calif., has become assistant engineer of the American Airplane & Engine Corp., Farmingdale, Long Island, N. Y. Previous to 1929, he had been connected with the Materiel Division of the Air Corps at Wright Field.

RALPH D. NYE, recently chief engineer for the Wheeling (W. Va.) Mold & Foundry Co., has joined the Lewis Foundry & Machine Co., Coraopolis, Pa., on sales and engineering work.

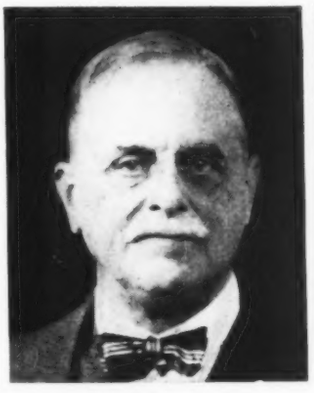
BEN C. PARSONS, formerly vice-president and chief engineer of the Hurricane Aviation Corp., Houston, Texas, has become chief engineer with the Hurricane Aircraft Division, Scripps Motor Co., Detroit, Mich.

ARTHUR R. PROUTY, formerly engineer with the Mack-International Motor Co., New York City, has become an engineer with the Russell Mfg. Co., Middletown, Conn.

DR. MICHAEL I. PUPIN of Columbia University will receive the John Fritz Gold Medal, highest of American engineering honors, for his achievements as "scientist, engineer, author, inventor of the tuning of oscillating circuits and the loading of telephone circuits by inductance coils." The award, which was unanimous, was made by a board representing the four national engineering societies. Dr. Pupin is professor of electro-mechanics and a director of the Phoenix Research Laboratory.

H. D. REED, of the Bishop Wire & Cable Co., New York City, has been appointed National Electrical Manufacturers' Association representative on the Standards Council of the A.S.A., and H. A. CALDERWOOD, electrical engineer, National Molding Division, Electrical Products Corp., Pittsburgh, Pa., has been appointed alternate. Mr. Reed succeeds R. W. E. MOORE.

KENNETH W. REED, mechanical and industrial engineer and formerly consulting engineer for the Warner & Swasey Co., Cleveland, has become associated with ERNEST L. RICHTER, industrial engineer. The latter, formerly with the Trundle Engineering Co., and later with the National Lamp Works of General Electric Co., Cleveland, has organized Richter Engineers, 1117 Schofield Bldg., Cleveland.



Elihu Thomson

Norman Tilley

DR. CALVIN W. RICE, secretary of the A.S.M.E. for the past 25 years, will be made an honorary member.

RALPH N. ROBERTSON, formerly chief mechanical engineer for the Blaw Knox Co., Pittsburgh, has joined the Atwood-Bradshaw Corp., Pittsburgh.

SAMUEL E. RUSINOFF, formerly mechanical designer of the National Lock Washer Co., Newark, N. J., has become purchasing engineer in the machine-tool-building division, Amtorg Trading Corp., New York City, commercial representative of the Soviet in this country.

DONALD M. SCOTT, former vice-president of the Gould Coupler Co., has been elected a vice-president of the Buffalo Electric Furnace Co. THOMAS H. NELSON of the Midvale Steel Co. and DR. GILBERT E. SEIL of E. J. Lavino & Co., Philadelphia, have been added to the Buffalo Electric Furnace engineering staff.

B. S. SHENSTONE, formerly with the Junkers Flugzeugwerk, A. G., Dessau, Germany, has joined the Supermarine Aviation Works, Ltd., Southampton, England.

E. B. SHERRICK, formerly designer with the Detroit Aircraft Co., Detroit, Mich., has become layout draftsman for the Cadillac Motor Car Co., Detroit.

JAMES M. SHOEMAKER, formerly lecturer on aeronautic engineering at the University of Southern California, Los Angeles, has become assistant aeronautic engineer with the National Advisory Committee for Aeronautics, at Langley Field, Va.

GEORGE R. STROHL, previously with the International Motor Co. factory, Allentown, Pa., has become special equipment engineer with the Autocar Co., Ardmore, Pa.

ERNEST VON MERTENS, formerly assistant superintendent of the Apollo Magneto Co., Kingston, N. Y., is now engineer for the Scintilla Magneto Co., Sidney, N. Y.

N. E. WAHLBERG, chief engineer of the Nash Motors Co., Kenosha, Wis., since the company's founding in 1916, has been elected vice-president in charge of engineering.

FRED A. WALES has been elected president of Aluminum Colors, Inc., owner of the Alumilite process for treating and coloring aluminum and its alloys. Mr. Wales became associated with the company shortly after it was organized in 1929 and in the capacity of vice-president he was actively engaged in the development of the process. RALPH E. PETTIT has been appointed sales engineer. He was formerly in the research department of the Aluminum Co. of America. Offices of the company have recently been moved from 401 Michigan St. to 537 East Washington St., Indianapolis, Ind.

W. HENRY WYCKOFF, formerly employed on tractor-engine layout and detail work for the Cheliabinsk Tractor Co., Detroit, Mich., recently entered the employ of the Chrysler Motor Co., Detroit, as a draftsman.

NEW MATERIALS AND PARTS AND ✦ ENGINEERING EQUIPMENT ✦

"Enduro-FC" Free-Cutting Stainless Steel

An alloy combining the free-cutting qualities of Bessemer screw stock with the corrosion- and heat-resisting characteristics of stainless steel has been placed on the market by the Republic Steel Corp., Central Alloy Division, Massillon, Ohio. This alloy is known as "Enduro-FC" and is a high chromium alloy which, because of its free-cutting characteristics, will give lower cost in parts requiring turning, boring, drilling, threading, grinding and polishing operations. A typical analysis is: carbon, 0.05 to 0.12 per cent; manganese, 0.25 to 50 per cent; silicon, 0.50 per cent maximum, and chromium, 12.5 to 15 per cent. Typical physical properties of the hot-rolled steel are: Yield point, 106,300 lb.; tensile strength, 137,900 lb.; per cent elongation in 2 in., 2.5; per cent reduction in area, 2, and Brinell hardness, 286.

Brown & Sharpe Pressure Relief Valve

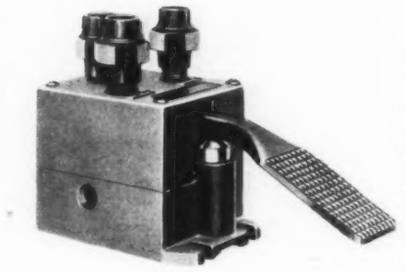
Developed for use with hydraulically operated machinery, a pressure relief valve has been placed on the market by the Brown & Sharpe Mfg. Co., Providence, R. I. This valve is particularly adapted to operate in connection with hydraulic mechanisms and with the Nos. 53 and 55 rotary geared pumps.

By removing the hexagon cap and turning the adjusting screw, the compression on the valve springs may be adjusted so that the valve will operate at pressures from 0 to 200 lb. per sq.in. Guides on the valve prevent fluttering and noisy operation. Features of the device are the large valve chamber, which permits a ready escapement for the bypassed liquid, and the double spring arrangement which gives wide range and flexibility. The valve is made to take 1-in. piping.

"Logan" Model "GN" Foot-Control Air Valve

A new Model GN foot-control air valve, being introduced by the Logansport Machine Co., Logansport, Ind., is of the single-pedal reversing type. No springs are used for pedal return, thereby eliminating one cause of valve failures. A small air piston

Brown & Sharpe Pressure Relief Valve for use with hydraulic systems and the Nos. 53 and 55 rotary pumps



mounted under the foot pedal automatically returns the pedal and reverses the valve when the operator's foot is removed. These valves are regularly manufactured in $\frac{3}{8}$-, $\frac{1}{2}$-, $\frac{3}{4}$- and 1-in. pipe sizes.

"Hylastic" Vanadium-Manganese Steel

Improvements in its "Hylastic" intermediate manganese steel have been made recently by the American Steel Foundries, 410 North Michigan Ave., Chicago. Ill. It is generally conceded that an intermediate manganese steel has valuable characteristics but that erratic results are common. This type of steel often shows decided segregation, and if the manganese is excessive, this segregation results in the formation of martensite in the manganese-rich areas when the steel has been cooled rapidly in air.

The addition of approximately 0.10 per cent vanadium to this steel produces a marked improvement in micro-structure and physical properties. Grain growth is decidedly retarded, and the vanadium addition makes possible a different ratio between the carbon and the manganese, which results in a steel with better physical properties and without manganese segregation. Uniform struc-

ture is obtained and therefore uniform physical properties. The yield points and impact values are also raised, together with ductility. Depending upon the carbon content, seven samples of steel gave the following range of characteristics. Elongation, 26 to 30 per cent; reduction in area, 54 to 62 per cent; yield point, 69,400 to 85,900 lb. per sq.in.; tensile strength, 93,450 to 108,800 lb.

Lyon "Li-flat" Cabinets

Sectional "Li-flat" cabinets for storing blueprints and drawings flat are offered by the Lyon Metal Products, Inc., Aurora, Ill. Two or more cabinets can be stacked on a base and no finishing top is required. Each stection consists of a unit of five drawers which can be secured with a wide variety of compartment arrangements. Either a closed base 6 in. high or an open base 12 in. in height can be furnished for any of the five sizes of cabinets.

From one to 16 compartments are regularly supplied, according to the size of the drawer. Inside drawer dimensions vary from $20 \times 25\frac{9}{16}$ in. up to $38\frac{1}{2} \times 50\frac{3}{8}$ in. All drawer heights are 3 in. Drawers are punched both on the sides and bottom on 3 in. centers for the insertion and adjustment of dividers. Each drawer is fitted with brass handles and a label holder.

Convenience and utility are combined in the Lyon "Li-flat" cabinet for storing blueprints and drawings flat

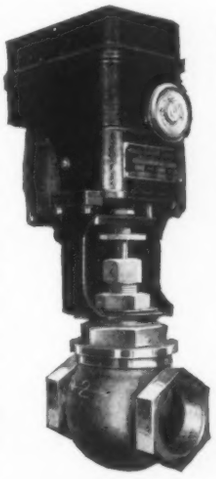
Cutler-Hammer Rubber Attachment Cap

An unbreakable attachment cap with hand grip has been announced by Cutler-Hammer, Inc., 205 North 12th St., Milwaukee, Wis. This cap is made of soft, resilient rubber with the blades fastened to a Bakelite disk imbedded in the rubber base. The

hand grip is approximately $1\frac{3}{4}$ in. long. The cap is suitable for industrial application and is rated at 15 amp., 125 volts or 10 amp., 250 volts, and is known as Cat. 7761.

"Automatic" Type 1 Control Valve

The Automatic Temperature Control Co., Inc., 34 East Logan St., Philadelphia, Pa., has added to its line of motor-operated controllers a compact unit known as Type 1, which is designed to handle valves of either the rotary or slide-stem types. This controller is shown mounted with a single-seated, type GS globe valve as supplied for high-presssure gas, using inspirator-type burners. For low-pressure gas using inspirator-type burners, a type BP butterfly valve is available, while for steam or water at pressures up to 250 lb. per sq.in., a type GSP globe valve having a single-seated pilot is recommended. On gas-fired installations, by-pass piping and by-pass hand valves can be eliminated, as provision is made at the control valve for minimum fuel supply. The controller may be located in either a vertical or a horizontal pipe line.



In design, the screw shaft geared to the motor imparts straight line motion to the operating yoke, which opens or closes the valve in two seconds. Positive valve positioning is assured, and declutching takes place before the motor comes to rest. This design prevents valve jamming or sticking at either extreme of its stroke. A fractional turn of the motor shaft operates a transfer switch built into the controller, and hence only momentary contact is required at the actuating instrument. No relay is required as the motor starting current is but 0.15 amp.

Union Special Carburizing Steel

A special carburizing steel, which will not develop soft spots when case-hardened, has been developed by the Union Drawn Steel Co., Beaver Falls, Pa. The chemical specifications are as follows: Carbon, 0.10 to 0.20 per cent; manganese, 0.60 to 0.90 per cent; phosphorous, 0.04 per cent maximum; sulphur, 0.05 per cent maximum, and silicon from 0.20 to 0.30 per cent. The manganese and silicon contents are higher than in the SAE-1015 or SAE-1020 types of steel, as it has been found that manganese and silicon in these proportions give a dense homogeneous steel and one which responds readily to casehardening heat-treatments. A low sulphur content acts to produce the best carburized parts, and the steel should not be confused with the high-manganese, screw-stock type of carburized steel.

The various properties obtained

NEW MATERIALS AND PARTS

from test on ¾-in. round bars are as follows: ultimate strength, cold drawn, 97,190 lb.; when quenched into water, 1,600 deg. F., 110,250 lb.; when quenched into water, 1,400 deg. F., 110,950 lb.; and double quenched at 1,600 and 1,400 deg. F., 107,150 lb. The Brinell hardness was as follows on a ¾-in. round bar: At the center, when quenched, 1,600 deg. F., 228; when quenched, 1,400 deg. F., 207; double quenched, 1,600 and 1,400 deg. F., 202; hardness at the surface, cold drawn, 183.

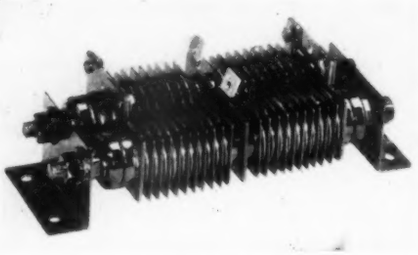
"Red Band" Adjustable-Shaft Motor

An adjustable-shaft "Red Band" motor is being manufactured by the Howell Electric Motors Co., Howell, Mich., for use with motor-driven pumps. This motor has a fine micrometer adjustment of the shaft, which is accomplished by a cast-steel housing machined with 16 threads per in. All adjustments can be made while the motor is in operation. By placing a wrench on the micrometer adjustment, a "gallon per minute meter" on the pump and an ammeter on the motor, the motor can be adjusted to maximum capacity of the pump at maximum efficiency of the motor per horsepower in not more than five minutes.

This adjustable-shaft feature is obtainable for both vertical and horizontal motors, constant or multi-speed motors, and in single-phase or polyphase designs. It offers the pump manufacturer the advantages of fine adjustment, complete protection from entrance of abrasives, and a design which is special for deep well, turbine and vertical or horizontal pump duty.

"B-L" Small 75-Watt Rectifier

A dry metallic rectifier of large continuous rating has been announced by the B-L Electric Mfg. Co., 19th & Washington Ave., St. Louis, Mo. This rectifier is an addition to the high-voltage rectifiers manufactured



by the company and has a continuous output rating of 75 watts. It occupies a space of only 7¼x2¾x2¼ in., and will operate directly from a 115-volt a.c. line. Particular applications are elevator controls, brake magnets, solenoids, magnetic chucks and magnetic separators. Convenient mounting of the device is a feature.

Hammond Variable-Speed Pulley

A variable-speed pulley capable of transmitting up to 15 hp. has been developed by Hammond Machinery Builders, Inc., Kalamazoo, Mich. This pulley has a ratio of 1⅓ to 1, and it is possible to secure an unlimited number of speeds in this ratio. The maximum revolutions per minute recommended is 3,000 r.p.m.

This variable-speed pulley can be used with V-belts, and takes up very little additional room over that of the ordinary V-belt pulley or sheave. In the accompanying illustration *A* shows the motor and pulley, but with other components are mounted. When provided with a vacuum contact, the light relay can control a circuit handling up to 1,320 watts.

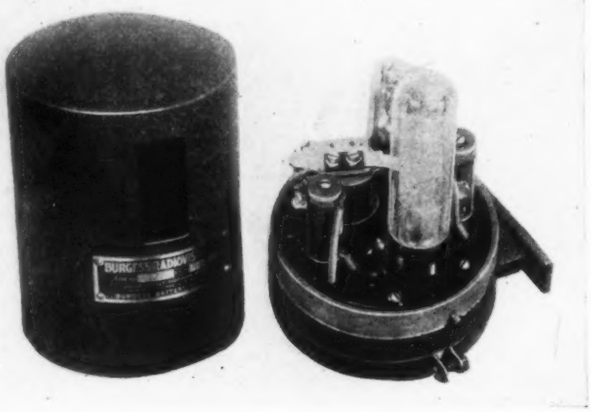
As companion equipment, the light source units, available in a.c. and d.c. models, are also offered. Each unit contains a 12-volt, 21-cp. bulb, as well as a focusing optical system. The unit can be housed in an aluminum case.

Above—Burgess Light Source Unit; below—light relay

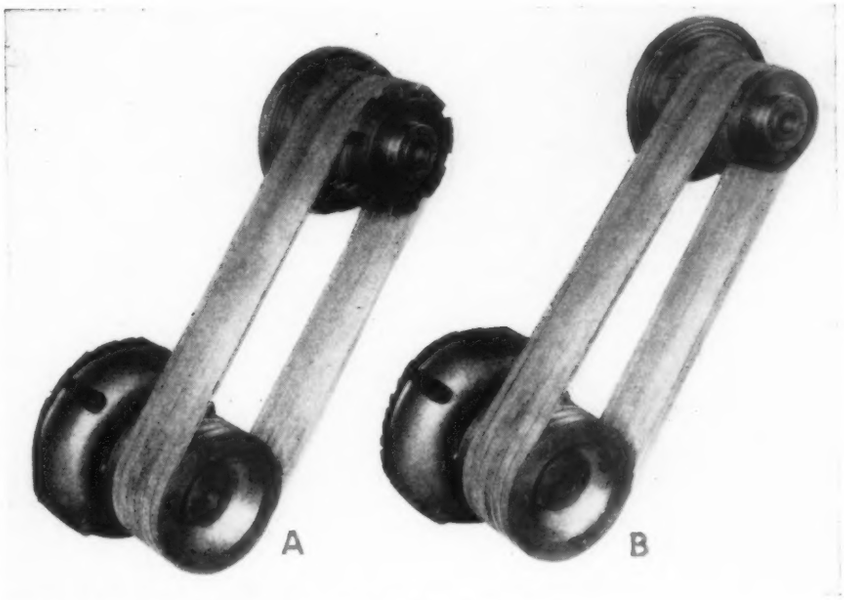
Burgess Light Relay and Light Source Units

Complete, ready-to-use light relay and light source units are announced by the Radiovisor Division of the Burgess Battery Co., 202 E. 44th St., New York, N. Y.

The units are designed around the Radiovisor bridge or light-sensitive cell. The light relay units are available in both a.c. and d.c. models for use on usual power supplies. The units are in the form of an aluminum housing with window, containing a circular platform on which the bridge, tubes and



NEW MATERIALS AND PARTS

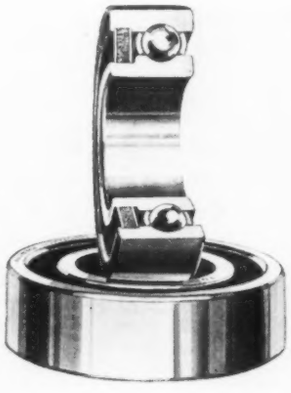


Hammond Variable-Speed Pulley expanded at *A* to drive at near the motor speed. Maximum ratio is 1¾ to 1

the variable-speed pulley expanded, to operate the spindle at a speed of 2,000 r.p.m. In the same figure *B* shows the pulley closed.

Norma-Hoffmann Series "7000" Felt-Protected Ball Bearings

In the "7000" series of felt-protected closed-type ball bearings, the Norma-Hoffmann Bearings Corp., Stamford, Conn., presents an all-steel,



lubricant-packed, dirt-proof bearing embodying latest improvements toward simplification in mounting and lubrication, and a reduction in cost of machining and assembling. Wide, solid inner and outer rings give maximum contact on shaft and in housing, and the design is such that the bearing can be clamped on both sides. It will carry substantial thrust loads in either direction, in combination with the radial load. The "Greaseal" feature consists of a felt washer and a thin fiber ring interposed between split snap rings held in a groove in the outer ring. The inner ring is recessed to present a shoulder which, with the felt washer, forms a labyrinth. The bearing is made in a full range of sizes, and interchanges in over-all dimensions with all other makes of self-protected bearings.

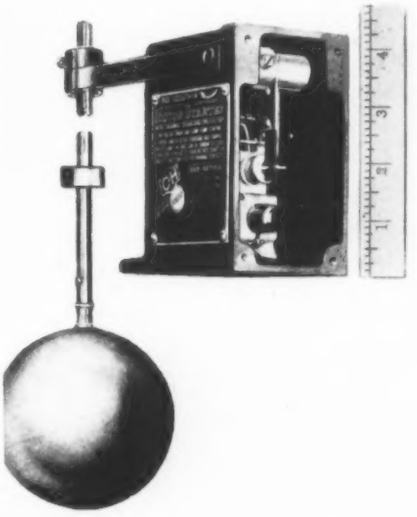
Allen-Bradley Face-Plate Speed Regulator for Slip-Ring Motors

A speed regulator of the face-plate type for varying the resistance in the secondary circuit of slip-ring motors is a recent development by the Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis. The Bulletin 555 speed

regulator, as this device is known, is suitable for motors up to 25 hp., and is provided with a faceplate of either 25 or 75 amp. rating with an operating handle outside the inclosing cabinet. The inclosing cabinet can be omitted. Auxiliary contacts are provided for closing a separate magnetic primary switch when the hand lever is on the first speed position. Disconnection of the motor from any cause makes it necessary to move the lever back to the first position to pick up the primary switch, thereby preventing starting of the motor without all resistance in the three phases.

Cutler-Hammer Float-Operated Motor Starter

For small a.c. and d.c. motors on sump pumps, open tanks and similar application, the new float-operated motor starting switch announced by Cutler-Hammer, Inc., 205 No. 12th St., Milwaukee, Wis., provides across-



the-line starting, thermal overload protection, and is small in size. For larger motors, this same device can be provided without overload protection so it can be used as a master switch in the control circuit of a separate automatic starter. It can also be furnished without the float accessories for use as a lever-operated master switch. The thermal overload relay is free-tripping and must be manually reset. It can not be held closed on an overload.

Maximum ratings for this starter are: a.c. ½ hp., 110 or 220 volts, single phase; d.c., ⅙ hp., 115 volts.

PUBLICATIONS

FOR THE ENGINEER'S LIBRARY

A. C. Instruments. The Roller-Smith Co., 233 Broadway, New York, N. Y., has issued Bulletin No. 160 on a.c. portable instruments, comprising ammeters, volt-ammeters, wattmeters, frequency meters, and power-factor meters.

Ball and Roller Bearings. The Bantam Ball Bearing Co., South Bend, Ind., has issued manual No. 11 on its line of ball and roller thrust and radial bearings. For the first time dimensions and load capacities of heavy-duty-type roller bearings up to 29½ in. bore and 48-in. O.D. are published. Special bearings are also illustrated, as well as recommended mountings and enclosures. Engineering data are appended.

Belt. A careful revision of the 1929 edition of Rhoads Belt User's Book has been issued by J. E. Rhoads & Sons, 35 North Sixth St., Philadelphia, Pa. The specific suggestions, rules, tables and charts of previous editions have been retained, and brief write-ups on short-center drives and group or individual drives have been added. The booklet contains seventy 4x6-in. pages.

Contact Points. The Fansteel Products Co., Inc., North Chicago, Ill., has issued a booklet "Metallurgy and Design of Contact Points," illustrating the process of production and the finished products and available sizes of contact points manufactured by the company.

Corrosion Report. The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has issued a report of Committee A-5 on "Corrosion of Iron and Steel," covering field tests of metallic coatings and a progress report on embrittlement of steel. Copies cost 50 cents each.

Corrosion-Resistant Alloys. The Robert W. Hunt Co., 2200 Insurance Exchange, Chicago, Ill., has issued a pamphlet entitled "Combating Corrosion with Alloys," containing reprints of articles by two of its metallurgists.

Die-Castings. The New Jersey Zinc Co., 160 Front St., New York City, has issued a booklet entitled "Zinc Die-Castings," which pictorially presents the advantages of zinc-base die-castings in a wide variety of products ranging from business machines to novelties and toys. A considerable number of products are illustrated. Properties of die-cast Zamak-2 are appended.

Flexible Couplings. The Morse Chain Co., division of Borg-Warner Corp., Ithaca, N. Y., has issued bulletin No. 47 on its flexible couplings, describing the features of these products, how to select them, horsepower curves, dimensions and prices, and installation views. The booklet is illustrated throughout with unusually good photographs and line drawings, and presents the material in an easily readable form.

Gears. The International Nickel Co., Inc., 67 Wall St., New York, N. Y., has issued a bulletin, "Gears Made of Armor Plate," dealing with the use of 5 per cent nickel and Krupp analysis (nickel and chromium) carburizing steel for motor truck gears and pinions.

Pressed Steel Museum. The publication *"Industry,"* published by the Associated Industries of Massachusetts, 950 Park Square Bldg., Boston, Mass., in the April 18 issue describes the Worcester Pressed Steel Museum, which is specially housed in a building designed for it and comprises in one section an armory containing perhaps the most extensive collection of ancient and medieval armor weapons to be found and also another section devoted to modern products manufactured from pressed steel. The museum building is one of a group comprising the Worcester Pressed Steel Co., Worcester, Mass., and offers engineers an opportunity to study side by side the craftsmanship of early artisans, and the most outstanding examples of modern sheet metal design and manufacture.

Pumps, Centrifugal. The Worthington Pump & Machinery Corp., Harrison, N. J., has published several bulletins on centrifugal pumps as follows: Specification Sheet W-312-S2A, superseding W-312-S2, on type L, single-stage volute pumps, No. 8; type LA, single-stage volute, Nos. 6 to 12, specification sheet W-312-S3A; type LL, single-stage volute, specification sheet W-312-S9; type UB, two-stage volute, specification sheet W-318-S3A, and groups C, D, L, R, and U pumps for sumps, specification sheet WD-310-B3.

Pumps. Schutte & Koerting Co., Philadelphia, Pa., have issued Bulletin No. 17A on pumps for oils and other liquids. These SK gear pumps can be furnished for all working pressures up to 1,500 lb. per sq.in., and for capacities up to 500 g.p.m.

Mechanical Rubber Goods. The Diamond Rubber Co., Inc., Akron, Ohio, has published a new edition of its mechanical catalog, which describes new items recently brought out, as well as standard items.

Motors. The Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio, has issued Bulletin No. 210 on Type T two-pole d.c. motors.

Motors. The Wagner Electric Corporation, St. Louis, Mo., has published Bulletin No. 167 on small motors, giving electrical characteristics and construction information.

Motors. The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued leaflet 20516 on single-phase motors suitable for application to pumps, compressors, ventilating fans, blowers, farm machinery, and other equipment where high-starting and high-accelerating torques are necessary. These motors have renewable pre-wound cores.

Recording Instruments. The General Electric Co., Schenectady, N. Y., has issued Bulletin No. GEA-1061D, superseding 1061C, on Type CD recording instruments for alternating- and direct-current systems.

Sheet Metal Design. The Youngstown Pressed Steel Co., Warren, Ohio, has issued "Adventures in Redesign," No. 3, showing many examples of redesign for sheet metal construction of household equipment, industrial equipment and other lines where better appearance, reduced weight, and cheaper cost have resulted.

Specifications for Materials. The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has issued a pamphlet entitled, "The Economic Significance of Specifications for Materials," which is a record of a symposium held under the joint auspices of the American Society for Testing Materials and the Western Society of Engineers.

Speed Reducers. The General Electric Co., Schenectady, N. Y., has issued bulletin GEA-1437 on built-in speed reducers for general-purpose, ball-bearing induction motors.

Switches. The Allen-Bradley Co., Milwaukee, Wis., has issued Bulletin 715 on automatic multi-speed across-the-line switches, and Bulletin 742 on an automatic increment starter for network systems.

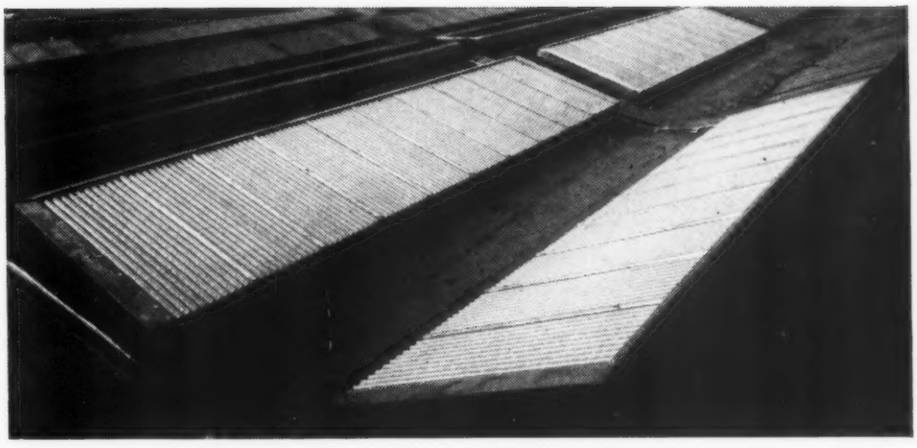
Transmissions. The Reeves Pulley Co., Columbus, Ind., has issued Catalog No. 99, descriptive of its complete line of variable-speed transmissions. Sixteen designs are shown, together with controls of various types. Charts and diagrams are used profusely.

Welded Steel Gears. Lukenweld, Inc., division of Lukens Steel Co., Coatesville, Pa., has issued a booklet entitled "Welded Steel Gears from Blanks of Lukenweld Construction," showing the manner of fabricating these welded steel gears and the various advantages.

Wiring Calculator. The Diamond Electrical Mfg. Co., Ltd., affiliated with the Square D Co., 1320 E. 16th St., Los Angeles, Calif., has developed a celluloid device for computing wiring and motor data. It contains two separate and distinct calculators, one for computing wiring and the other for motor data and fits conveniently into the pocket. It is based on the latest issue of the National Electrical Code, and does away with calculations or charts.

✦ ✦ ✦

EVERDUR



Everdur skylight frames, Jersey City train shed, Central Railroad of New Jersey.

. . . used throughout all industry for countless purposes

EVERDUR* METAL, an Anaconda alloy of copper (96%), silicon and manganese, meets the exacting requirements imposed by hundreds of different industrial applications. Fabricators use Everdur to make such diverse products as nails and man-hole steps, ventilating ducts and burial vaults, storage tanks and varnish kettles, welding rods and pickling tub equipment, propeller shafts and transmission line hardware, flag poles and meter parts—and enough others to fill this page with small type.

The outstanding advantages of Everdur include high strength, unusual corrosion-resistance, ready weldability and excellent machining qualities. It is easy to cast, roll, draw, spin, forge and press—and can be worked either hot or cold.

Everdur is produced exclusively by The American Brass Company, in the form of sheets, wire, rods, tubes, ingots, hot pressed parts and special shapes. Complete information on request. Ask for Anaconda Publication E-2.

*Reg. U. S. Pat. Off.

ANACONDA
from mine to consumer

The American Brass Company is equipped to meet industry's every demand for copper and copper-alloys in the form of sheets, wire, rods, tubes and special shapes. In addition to Everdur, special alloys include Ambrac, Tobin Bronze and a new free-cutting Phosphor Bronze Rod which turns almost as readily as yellow-brass. Inquiries welcomed.

THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Connecticut
Canadian Mill: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA COPPER & BRASS

8 Years' Satisfaction

with

REVERE BRASS FORGINGS

Drain outlets and connections, caps, hubs and packing nuts . . . these parts, and more, go into the manufacture of washing machines. For some of these parts, great strength is the chief requirement, for others finish is the important thing. In all of them, low cost is essential.

Revere Brass Forgings meet each and all of these specifications.

Revere Brass Forgings are exceptionally STRONG because they are twice wrought, once in extrusion and again in forging.

With minimum effort Revere Brass Forgings TAKE A HIGH POLISH, the reason being the close grain of the metal and the smoothness of surface obtained from contact with the highly finished dies.

Parts made from Revere Brass Forgings ARE LOW IN FINAL COST. This results naturally from savings in material, machining and finishing costs. In addition, there is less scrap due to more accurate dimensions. Also, tools are not dulled in machining the forgings due to the close grain and free cutting quality of the metal.

To all this, a prominent washing machine manufacturer testifies as follows: "We have used Revere Brass Forgings for the past eight years with great satisfaction. We find that forgings have a great advantage over sand castings both in quality and price. We also find that forgings are much better and count a great deal in the process of finishing, and upon completion they are very superior to sand castings."

In your own plant, there may be production problems which can be solved by Revere Brass Forgings. Revere offers you the services of its research and technical staff to develop forgings to meet your particular needs so that you can duplicate the satisfaction and savings obtained by the manufacturer mentioned.

For further information address Revere Copper and Brass Incorporated, 230 Park Ave., New York City.

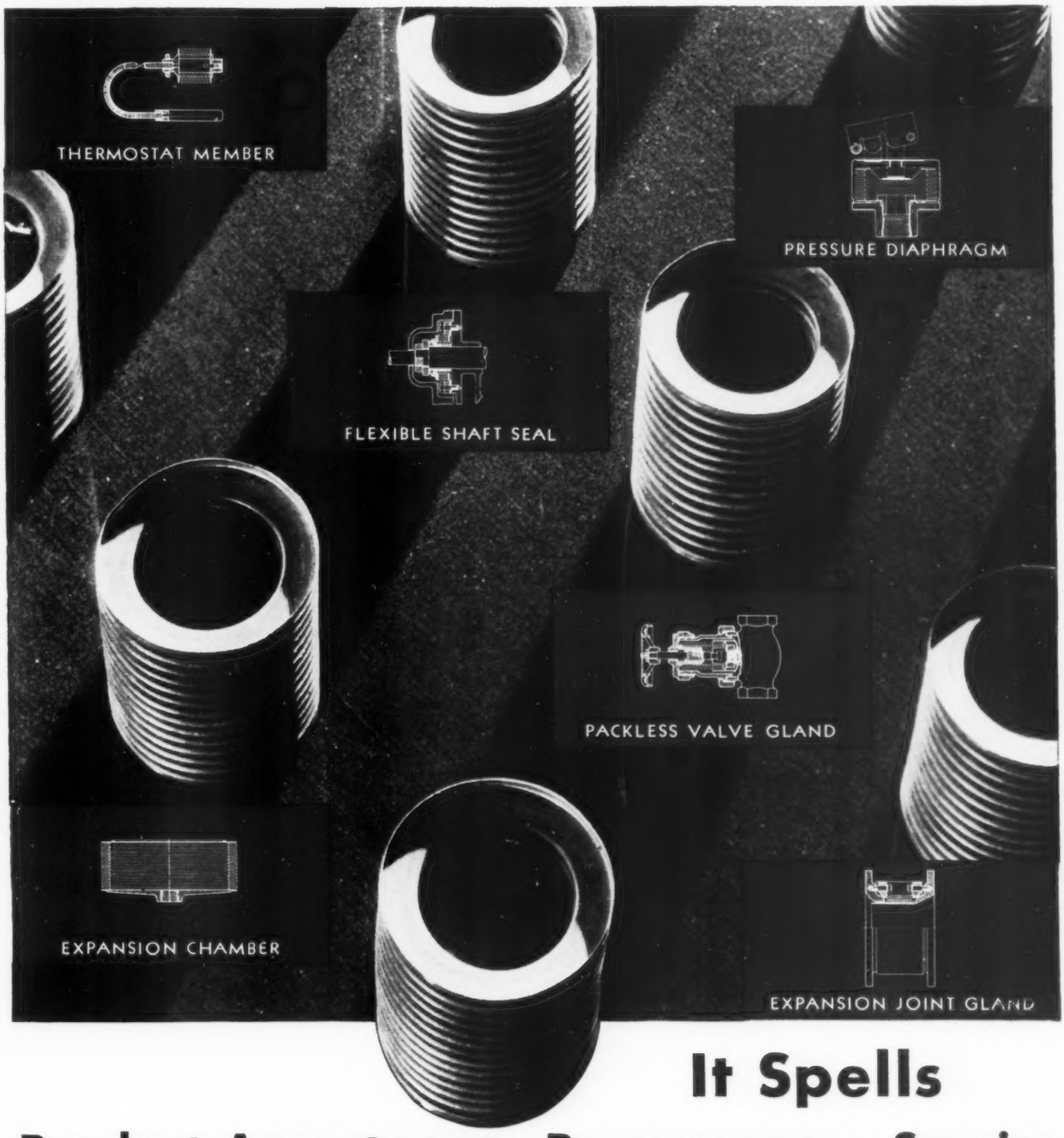
Revere Copper *and* Brass

INCORPORATED

Revere COPPER BRASS Products

Baltimore *Division, Baltimore, Md.* Michigan *Division, Detroit, Mich.* Higgins *Division, Detroit, Mich.*
Dallas *Division, Chicago, Ill.* Taunton-New Bedford *Division, Taunton, Mass.* Rome *Division, Rome, N. Y.*

EXECUTIVE OFFICES: NEW YORK CITY
GENERAL OFFICES: ROME, N. Y.



It Spells

Product Acceptance—Permanence—Service

It's Not Rubber—yet it stretches and contracts. It's Not Leather—yet it matches new leather's toughness. It's Not Packing—yet it has permanently solved the packing problem for valve, expansion joint and gland manufacturers. It has no feeling—yet it is used as one of the most sensitive elements for the control of heat and cold. It is hard cold metal—yet it is more than flexible enough to be used as seals for universal joints, as shock dampeners, as pressure diaphragms, as expansion chambers, as pump diaphragms.

It is the Sylphon Seamless Metal Bellows—a machine part that brings you an entirely new conception of metal's versatility—that will permit you to substitute permanence for short-lived materials previously demanded for flexibility at many vital points in machine construction.

Investigate the possibilities of Seamless Metal Bellows in solving your design problems.

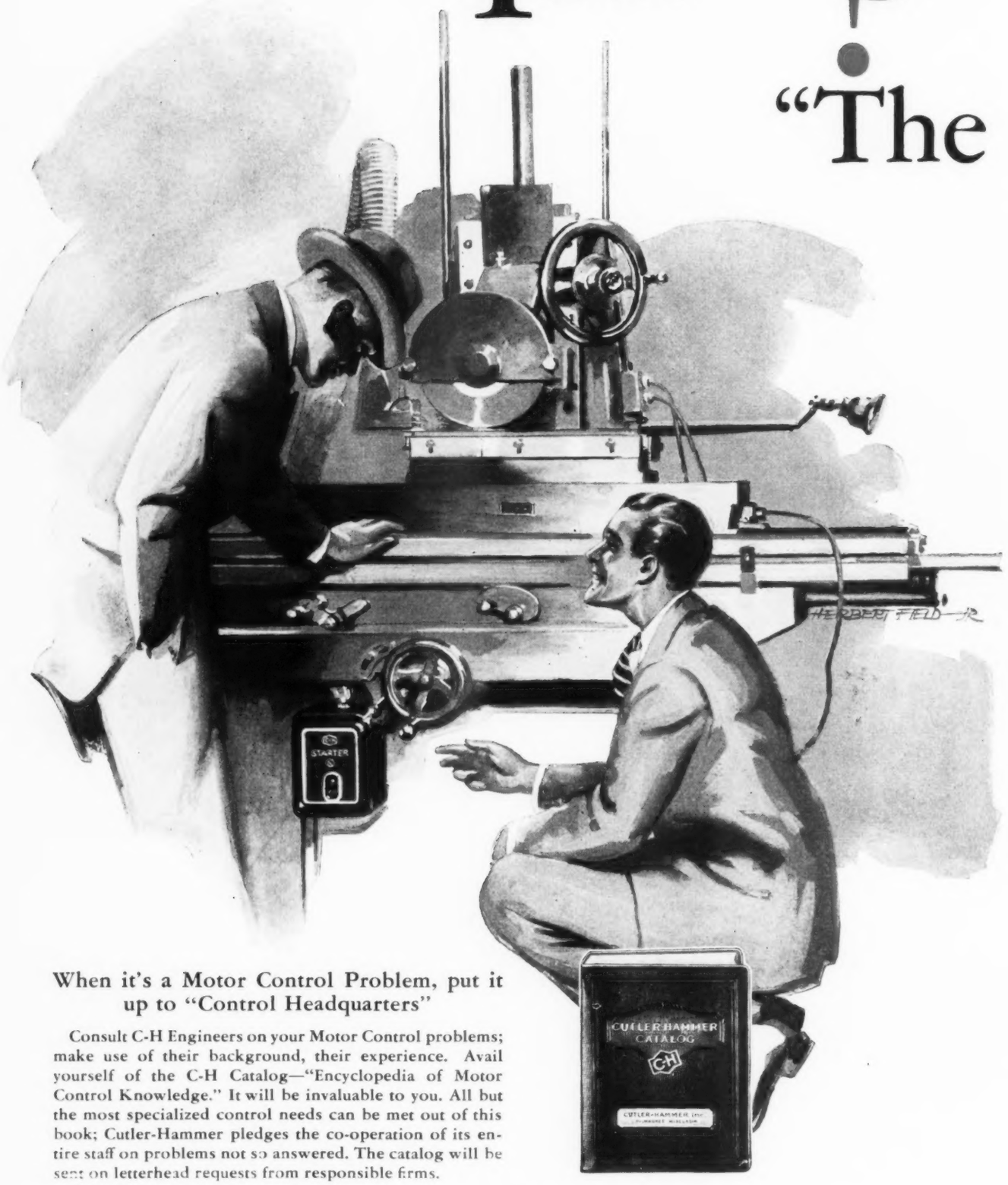
Sylphon Bellows as small as 11/16 inches O.D. and in various sizes up to 12 inches O.D. can be manufactured to your specifications.

Send for Bulletin XP-75.

Sylphon
Reg. U.S. Pat. Off.

FULTON SYLPHON CO.
KNOXVILLE, TENN., U.S.A.

That "?" "The



When it's a Motor Control Problem, put it up to "Control Headquarters"

Consult C-H Engineers on your Motor Control problems; make use of their background, their experience. Avail yourself of the C-H Catalog—"Encyclopedia of Motor Control Knowledge." It will be invaluable to you. All but the most specialized control needs can be met out of this book; Cutler-Hammer pledges the co-operation of its entire staff on problems not so answered. The catalog will be sent on letterhead requests from responsible firms.

C-H

—often it's straw that breaks the camel's back"

THESE days, every little feature about a machine is scrutinized and questioned by prospective buyers. When the talk turns to Motor Control, a familiar, accepted name swings the balance of preference your way by just that much, and an unfamiliar or less acceptable name swings the sale just as far the other way.

Not only is that logical, but it has been proven recently in a national investigation* among machinery buyers. They say, eight out of ten of them, that Motor Control is of increasing interest to them. And no wonder, for Motor Control is apt to decide the pace of production. In the majority of instances they stated a preference for C-H Control.

Don't let the shadow of a "?" about Motor Control fall across your machines. Prove that you have spared no effort to make your machines the finest—standardize on C-H Control, the product of nearly 40 years' experience solving Industry's Control problems. Interesting, usable data showing how C-H Motor Control can increase sales possibilities awaits you.* Designers, sales managers and salesmen all should see it. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1332 St. Paul Avenue, Milwaukee, Wisconsin

*Shown to you on request.

New sales asset on small-motor machines

—new C-H 9115 A.C. "X" 2 h.p. Manual Starter

Built to C-H heavy duty standards—not just a small starter "made heavy." Brings big motor protection and control to motors up to 2 h.p. Incorporates famed C-H Thermal Overload Unit—is "all but" automatic—practically every automatic starter feature except remote control itself. Resets with starting handle—nothing to renew—no delicate parts anywhere.

CUTLER HAMMER

C-H

The Control Equipment Good Electric Motors Deserve

NOW...

CAN BE FREELY

Carpenter—the first to introduce free-machining chromium iron—*again* takes the lead . . . this time with a free-machining chrome nickel stainless.

THREE years ago, Carpenter Stainless No. 5 was brought out . . . and you know how this free-machining chromium iron has more than backed up every claim made for it.

Now—in offering a free-machining 18-8 stainless steel—The Carpenter Steel Co. does so with the same full confidence in its product. We do not say that this 18-8 stainless machines quite as easily as Carpenter Stainless No. 5. What we do claim, however, is that it *machines more freely than any other 18-8 stainless steel you've ever tried!*

Here are the properties of Carpenter Free-Machining 18-8 Stainless compared to standard 18-8 stainless steel.

PHYSICAL PROPERTIES

(Average Values)

	Standard 18-8 (Carpenter Stainless No. 4)	Free-Machining 18-8 (Carpenter Stainless No. 8)
	Hot-Rolled Unannealed	
Tensile Strength	100,000 lbs.per sq.in.	100,000 lbs.per sq.in.
Elastic Limit	50,000 lbs.per sq.in.	50,000 lbs.per sq.in.
Elongation in 2 in.	50%	45%
Reduction of Area	65%	56%
Izod Impact	100 ft. lbs.	70 ft. lbs.
	Annealed at 1825° F	
Tensile Strength	95,000 lbs.per sq.in.	95,000 lbs.per sq.in.
Elastic Limit	35,000 lbs.per sq.in.	33,000 lbs.per sq.in.
Elongation in 2 in.	57%	53%
Reduction of Area	71%	58%
Izod Impact	110 ft. lbs.	50 ft. lbs.

CORROSION RESISTING PROPERTIES

in a few representative chemicals

(Values show weight loss per sq. cm. per hour) Reagent	Temperature	Standard 18-8 (Carpenter Stainless No. 4)	Free Machining 18-8 (Carpenter Stainless No. 8)
50% Acetic Acid	80°F	.000000	.000000
50% Acetic Acid	Boiling	.000179	.000108
10% Aluminium Sulphate	80°F	.000000	.000000
10% Aluminium Sulphate	Boiling	.004460	.000000
20% Sodium Hydroxide	Boiling	.000004	.000000
Saturated Sol.Calcium Chloride	80°F	.000001	.000001
Moist Hydrogen Sulphide Gas	80°F	.000000	.000000
Saturated Sulphurous Acid	80°F	.000000	.000000

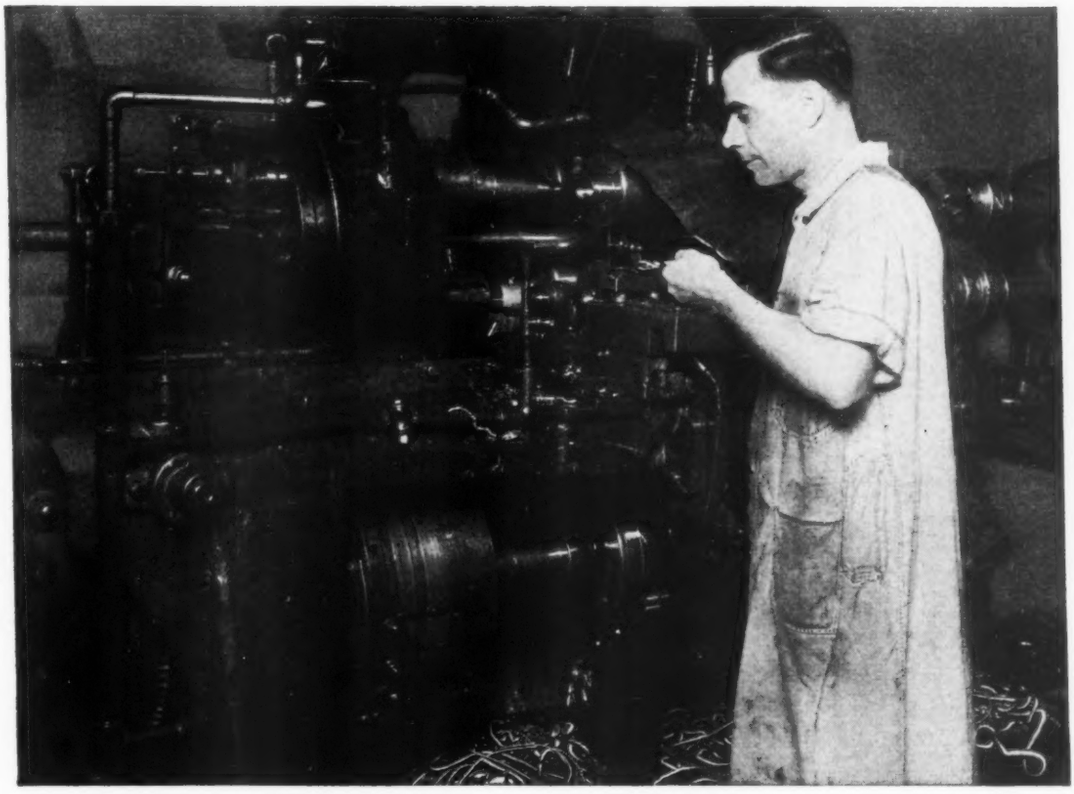
GALVANIC ACTION

There is no corrosive galvanic action between "Free-machining 18-8" and Standard types of "18-8" when used together in the same assembly.

Carpenter

Free-machining

an 18-8 Stainless that *MACHINED!*



STANDARD TOOLS . . . *such as form tools, twist drills, gun-barrel drills, taps and collapsible die heads . . . can be readily used with this free-machining 18-8 stainless steel.*

Let us send samples for you to try

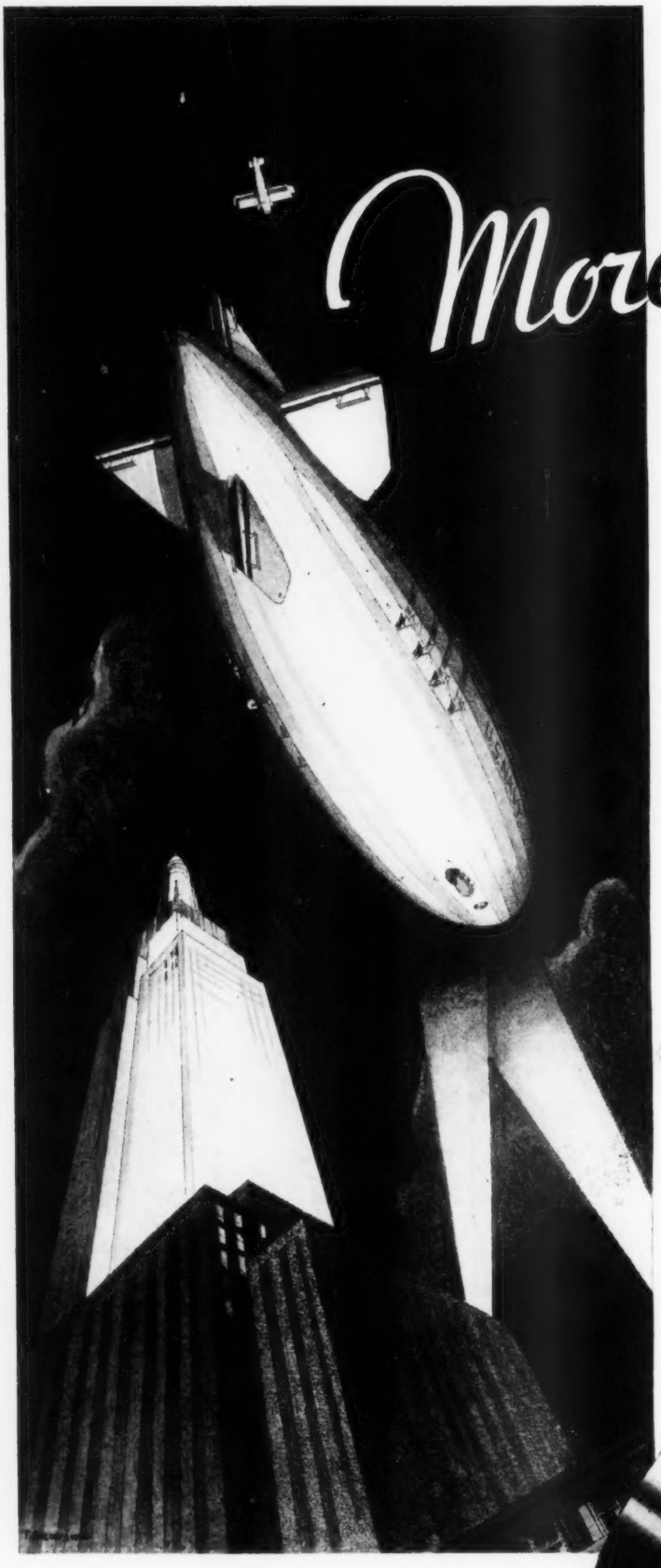
Carpenter Stainless No. 8 and Carpenter Stainless No. 4 may be used interchangeably for almost any corrosion-resisting purpose. The choice between them lies chiefly in the manner in which the parts are to be fabricated. Carpenter Stainless No. 8 (free machining 18-8) is recommended for parts that must be machined; Carpenter No. 4 (standard 18-8 material) for parts that are bent, drawn or formed to shape.

TODAY—drop us a line requesting samples of our new free-machining 18-8 stainless. Discover for yourself the ease with which Carpenter No. 8 responds to machining, grinding and polishing. It will be a revelation to you.

THE CARPENTER STEEL COMPANY
117 W. Bern Street Reading, Penna.

STAINLESS STEEL NO. 8

chrome nickel steel



Each of the eight 12-cylinder Maybach motors on the new U. S. S. Akron is equipped with 103 SKF Anti-Friction Bearings. Even the portable mooring mast has SKF Bearings in the spindle that lets the great ship swing with the wind.

More than 3,000

SKF BEARINGS On U. S. S. AKRON

The World's Greatest Single Tribute to *Any* Bearing

When the U. S. S. Akron soars aloft, her eight great Maybach motors turn on SKF Bearings . . . her control mechanism operates on SKF Bearings . . . her right angle propeller drives are equipped with SKF Bearings . . . her rudder hinges, elevators, ailerons, mooring spindle, all move upon SKF Bearings.

Throughout this new gigantic marvel of the air are more than three thousand SKF Bearings . . . the greatest single tribute ever paid to the design, the quality, the dependability of *any* bearing.

The same make of bearing was on the Spirit of St. Louis . . . the Columbia . . . the America . . . the Question Mark . . . the Graf Zeppelin . . . the same make of bearing has been on every ship of the air that has written aviation history across the skies . . . and selected solely upon the basis of PERFORMANCE!

SKF Industries, Inc., 40 E. 34th St., New York, N.Y.

SKF

BALL AND ROLLER BEARINGS

2774

INDIFFERENCE or ACTION

It is acknowledged that the product which offers more is met with orders, while indifference blocks the path of the unfit. By offering a better product —Synthane creates orders for itself. By using Synthane, manufacturers better their own products and—increase orders.

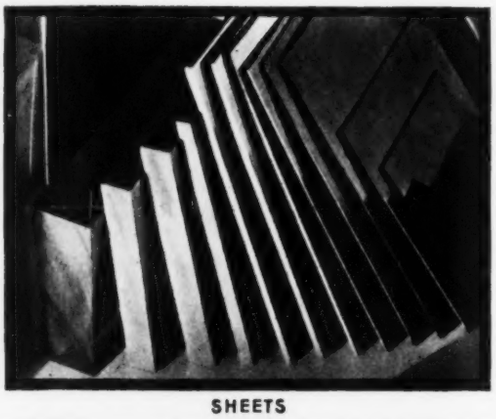
Positive uniformity, the constant characteristic of Synthane, makes for smoother production, less waste, and dependable performance. These are facts—capitalized every day by present users of Synthane. Are you familiar with Synthane? The reverse side gives more information.

SYNTHANE
Laminated Bakelite

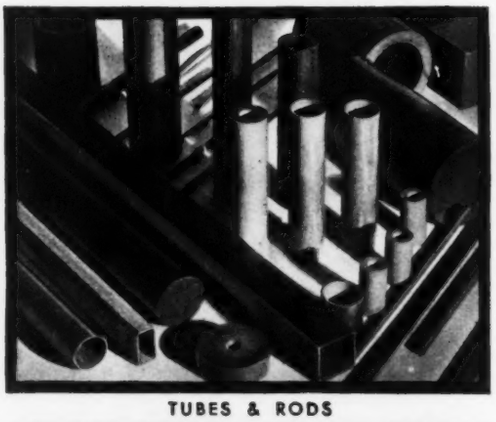
SHEETS—RODS—TUBES—FABRICATED PARTS—STABILIZED GEAR STOCK

SYNTHANE *LAMINATED BAKELITE*

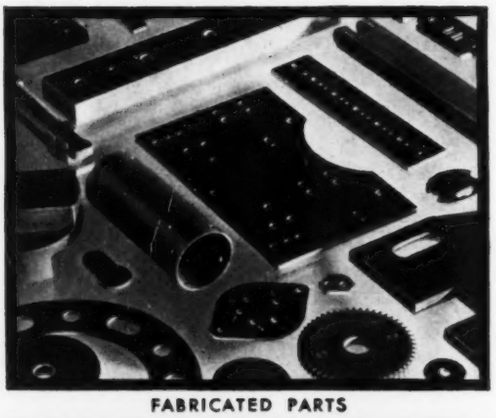
FOR EVERY SPECIFICATION



SHEETS



TUBES & RODS



FABRICATED PARTS

STABILIZED GEARS

No matter what your requirements, you will find a grade of Synthane specially designed to meet them.

Special grades made at no additional cost. All standard grades of Synthane, listed according to N. E. M. A. standards, are ready for immediate shipment.

GRADE X. For General Use where low moisture absorption and good machining and electrical properties are required. Paper base. Will punch up to 1/32" cold, and when heated, to greater thicknesses. Machines readily. See "Sheets", "Tubes".

GRADE XX. For Extremely Low Moisture Absorption and High Dielectric Strength. Paper base. Good machining qualities. Low moisture absorption. See "Sheets", "Tubes", "Rods".

GRADE XP. For Punching Operations. Paper base. Punches and shears cold up to 3/32"; punches and shears in thicker sizes depending on design of die and temperature of material. See "Sheets".

GRADE C. For Exceptional Structural and Impact Strength. Canvas base. Punches and machines readily. For use where high impact and transverse strength are required in connection with good insulating properties. See "Sheets", "Tubes", "Rods", "Gears".

GRADE L. For Fine Machining. Linen base. Usually required not over 1/8". See "Sheets", "Tubes", "Rods".

SHEETS. Size—36" square. Thickness—.010" upwards to 8". Color—Natural, Chocolate Brown and Black. Finish—Dull, High Gloss. Grades—X, XX, XXX, XP, C, L. Special as required.

TUBES. Length—36". Diameter—Inside diameter from 1/8" upwards. Outside diameter as required. Color—Natural and Black. Finish—Dull, High Gloss. Stocks—Round, Square, Rectangular. Grades—Wrapped X, C, L; Molded X, XX, C, L. Special as required.

RODS. Length—36". Diameter—1/8" upward. Color—Natural, Black. Finish—Dull, High Gloss. Stocks—Round, Square. Grades—Molded XX, C, L.

FABRICATED PARTS. Complete fabricated parts made to specifications in any of the above grades. Prompt deliveries to customers' requirements.

SYNTHANE STABILIZED GEAR STOCK for Silent Gears. Standard sheets 36" square. Thickness—upwards to 8". Easy to machine, strong, resilient and light. Gear blanks of any diameter in stock for immediate shipment.

SYNTHANE does not crack, break, dent, swell, warp, or cold flow. It has high dielectric strength, low moisture absorption, low surface leakage, good punching qualities, easy machineability, and high resistance to oils and chemicals. Genuine Bakelite resins, high-grade raw materials, specially designed machinery, controlled processes and supervised workmanship insure absolute uniformity of all Synthane products.

SYNTHANE

CORPORATION OAKS · PENNA

NEW YORK—CHICAGO—BOSTON—DAYTON—LOS ANGELES—SAN FRANCISCO

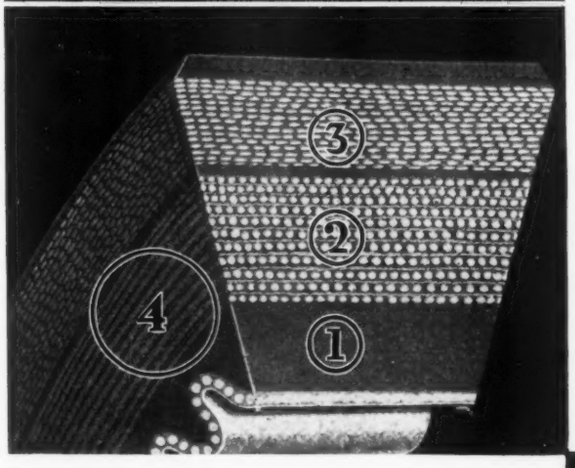
1932 DEMANDS...

★ more efficient plant operation...

★ lower production costs

INSTALL DAYTON COG-BELT DRIVES

COMPLETE DRIVES—PULLEYS AND BELTS—IN STOCK—ALL RATIOS—FRACTIONAL TO 100 H.P.

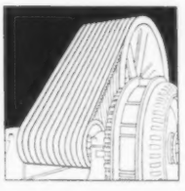


1 The Cog section . . . "built to bend" for extreme flexibility at high speeds, without heating, distortion, buckling or rippling.

2 The "Neutral Axis" . . . the strength section. Permanently pre-stretched by Dayton's patented process.

3 The Outer Section . . . gives balance. Composed of layers of vulcanized, strong cord fabric, bias-cut to accommodate bending without strain or distortion.

4 The entire belt is die-cut for precision and greater gripping power. Daytons are accurate and *stay* accurate.



Today's lower price levels make necessary the elimination of waste in every form. Production costs must be lowered. In the important field of power transmission, production managers are turning to Dayton Cog-Belt Drives to effect revolutionary economies.

For Dayton Cog-Belt Drives save the constant replacement costs and servicing charges that ordinary drives entail. They're far more ruggedly built. They have longer life. And that's not all. They're far more efficient. The accurately die-cut belts do not slip in the pulley grooves. Therefore, exact speed ratios are maintained through greater gripping power. This means more uniform—and far cheaper—production.

Then, too, Dayton Cog-Belts are "Built to bend"—easily, without heating, at high speeds. Their pre-stretched construction and mechanical design eliminate the necessity for constant "take-ups." No lubrication or dressing is necessary.

But these are only a few of Dayton's outstanding advantages. Let us give you the whole story of Dayton features that provide more dependable, more productive and profitable operation for your machinery. Remember, there is a Dayton Cog-Belt Drive for every type of machine, from the lightest to the heaviest.

Send for a Dayton Cog-Belt Catalog and sample section of the belt . . . now.

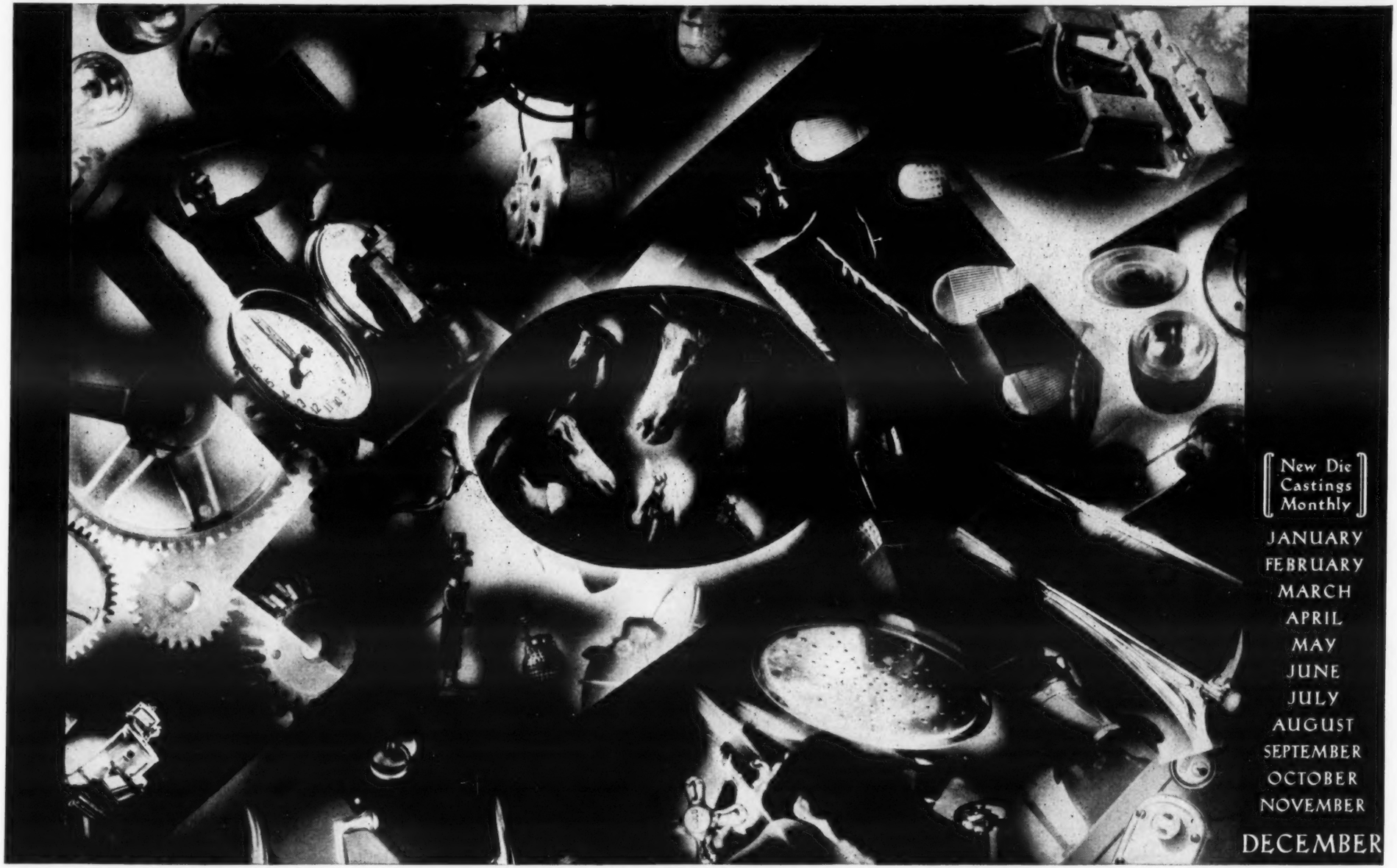
THE DAYTON RUBBER MANUFACTURING CO.
DAYTON, OHIO

FACTORY DISTRIBUTORS IN PRINCIPAL CITIES AND ALL WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY SALES OFFICES

1-22

Dayton
COG-BELT DRIVES

HORSE HEAD 99.99+% UNIFORM QUALITY ZINC FOR DIE CASTINGS

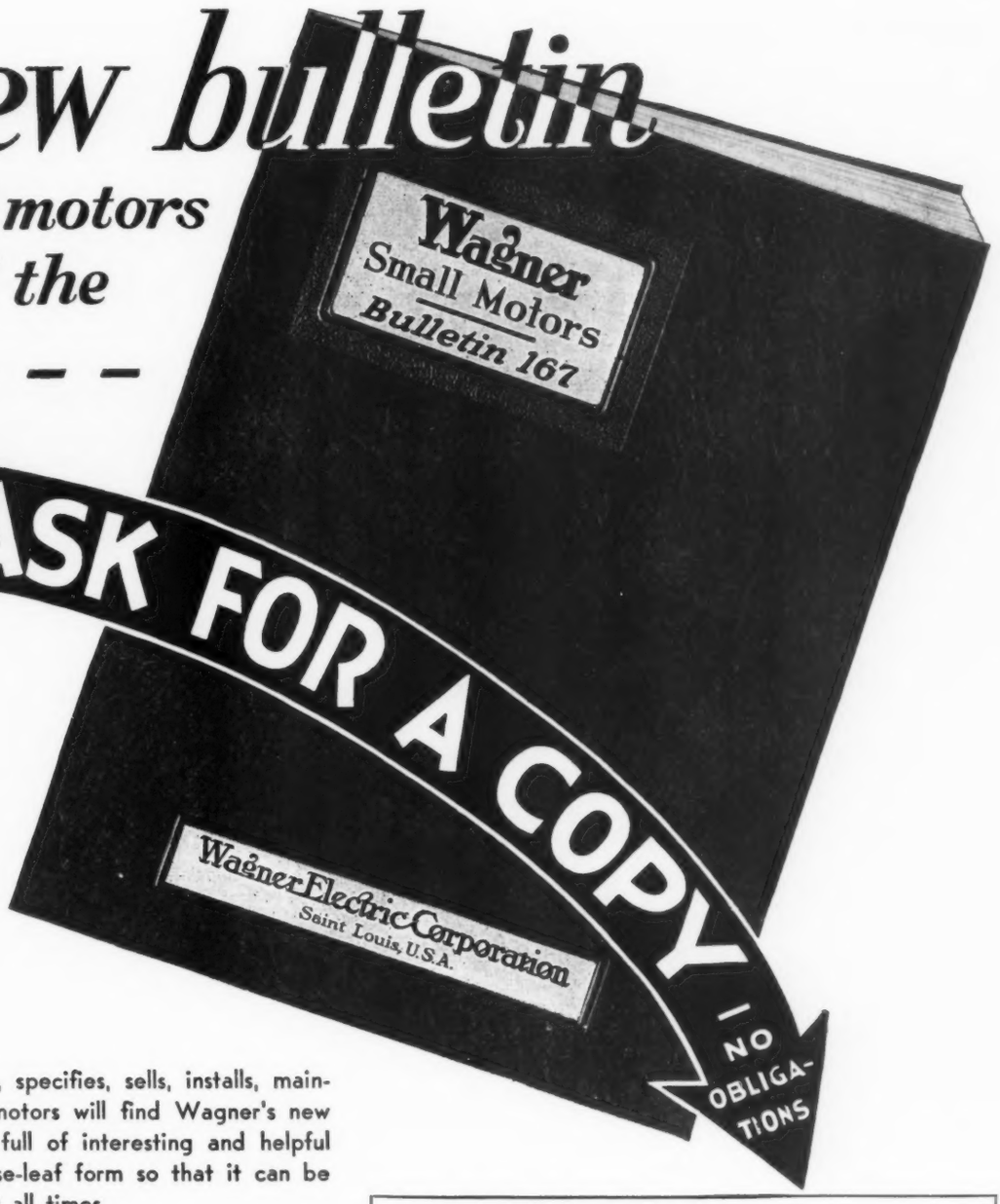


Zinc Metal Alloys ▪ Rolled Zinc ▪ Zinc Pigments
Sulphuric Acid ▪ Spiegeleisen

THE NEW JERSEY ZINC COMPANY 160 FRONT STREET NEW YORK CITY

A new bulletin

on small motors just off the press – – –



ASK FOR A COPY — NO OBLIGATIONS

Everyone who buys, uses, specifies, sells, installs, maintains and repairs small motors will find Wagner's new bulletin on small motors full of interesting and helpful information. It is in loose-leaf form so that it can be kept up to the minute at all times.

At the present time the bulletin consists of thirty pages —22 on single-phase repulsion-start-induction motors, and 8 on single-phase split-phase motors. Additional pages on polyphase squirrel-cage, single-phase condenser, and direct-current motors will be available in the near future.

Ask for a copy of this new bulletin. Place your name on a special mailing list to receive the additional pages as soon as they are printed. Just sign and mail the coupon. You do not obligate yourself in any way.

Wagner Electric Corporation
6400 Plymouth Ave., St. Louis, Mo.

Please PRINT your name and address to prevent mistakes in addressing you.

Wagner Electric Corporation,
6400 Plymouth Ave., St. Louis, Mo.

Gentlemen:

Please send me a copy of your new bulletin on Wagner Small Motors, and place my name on your mailing list to receive all additional pages as soon as they are available for distribution. I understand that this request obligates me in no way whatsoever.

Name_____

Firm_____

Address_____

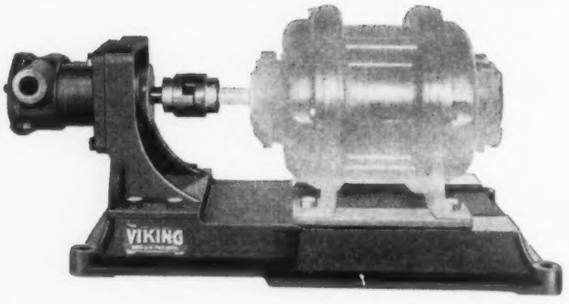
IMPORTANT! PLEASE ANSWER } Will you be in the market for motors in 1932?

Wagner Electric

MOTORS . . . TRANSFORMERS . . . FANS

S431-7XA

••Viking Hydraulic Oil ••Pumps



Adopted from a design with a twenty-year-old reputation for efficiency

The Viking Patented Principle . . . from which the Viking Hydraulic Oil Pump has been developed . . . enjoys a 20 year-old reputation for efficiency, economy, low power requirements and long life. There are in use today over 300,000 pumps employing the famous Viking Principle of just two moving parts.

Viking Hydraulic Oil Pumps are the direct out-growth of an insistent demand for an efficient, reasonably-priced high pressure pump. Its use is especially adapted to all fields of industry requiring hydraulic oil pressure . . . such as the operation of hydraulic lifts and elevators, or the actuation of movements on multiple drills, tappers, broaches and other machine tools. The Viking has JUST TWO elementary moving parts . . . no valves or tricky mechanisms . . . reduces wear to a minimum and results in low power requirements. Develops high mechanical efficiency . . . all models have opposite ports. Made of finest materials . . . in models of 5, 9, 13, 20, 35 and 45 G.P.M. capacity. Very reasonable initial cost. Let us send you the complete story. Write today for FREE Catalog VS-301-31 containing full information.

.... Viking Pump Company

Cedar Falls, Iowa

Our Catalog may help you

Its forty-seven pages contain a lot of interesting information on applications of Moccasin Bushings to tough and unusual jobs. The book shows how time-tested Moccasin Bushings, through the capillary attraction of their specially processed wood feeders, place an unbroken oil film on bearing surfaces and keep it there under high speeds and heavy loads.

Write today for this useful catalog and let us quote on your drawings and specifications.

Moccasin Bushing Company
Chattanooga, Tenn.

MOCCASIN Oil Distributing BUSHINGS
Special Shapes to Suit Your Requirements

PRESSED STEEL PULLEYS *for*

"V" or Round Belts

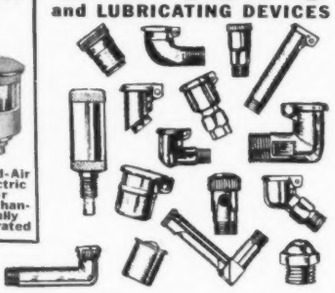
Washing Machines
Special Machinery
Compressors
Automobile
Pumps
Wherever
"V" or Round
Belts are
used

MEYER-FOLEY CO., INC.
GALESBURG, ILLINOIS

GITS Multiple Automatic Oiler

700 Styles and Sizes carried in Stock

OIL CUPS and LUBRICATING DEVICES



GITS BROS. MFG. CO.
1846-62 South Kilbourne Ave. .. CHICAGO

"SPLIT-PROOF and WARP-RESISTANT!"

— one of nine reasons why Douglas Fir Plywood is now being used by 24 classes of American industry!

AUTO CAMP KITS: Douglas Fir Plywood is well adapted for articles requiring tremendous strength per unit of weight, freedom from warping and splitting, and resistance to vibration and shock.

After repeated blows with a sharp heavy hatchet, you may finally hack a piece of Douglas Fir Plywood to bits—*but you can't split it!*

Prove this for yourself on the sample offered below. The experiment will impress you with the advantages of Fir Plywood's laminated, cross-grain construction, which approximately equalizes in both directions its shear strength, its tensile strength and its modulus of elasticity. Thus there is no plane of cleavage. And the separate laminations—pre-dried, cross-grained and bonded by a glue stronger than the wood fibers themselves—lock each other in place like clamps, providing unusual resistance to warping, swelling and shrinking, as well as splitting.

These and all the other special advantages listed below explain why Douglas Fir Plywood is replacing other materials in scores of industries. Yet this "Engineered Lumber" *costs no more per surface foot than ordinary boards*, and when ordered in special shapes and combinations of layers, drilled, treated, etc., it lowers freight charges and eliminates manufacturing steps.

BOXES AND SHIPPING CRATES: Fir Plywood's light weight lowers shipping costs, and shipments are securely protected. Nails will not pull out during rough handling.

Hundreds of production executives have cut costs with Douglas Fir Plywood—while building extra sales-appeal into their products. Check its advantages against *your own* problems. Mail the coupon for a free sample, helpful literature and comparative test data.

Nine Advantages

1. Split-proof and warp-resistant.
2. Water-resistant, unaffected by heat or cold.
3. Can be sawed, drilled, planed, and sanded.
4. Holds nails, screws, and rivets without splitting.
5. Takes any wood finish.
6. Comes in standard-size panels.
7. Special sizes and shapes upon order.
8. Costs no more per surface foot than ordinary lumber.
9. Stronger per pound than steel.

DOUGLAS FIR PLYWOOD

REAL LUMBER
Engineered for greater size and strength

DOUGLAS FIR PLYWOOD MFRS., Dept. 1231-S,
Sixth Floor, Skinner Building, Seattle, Wash.

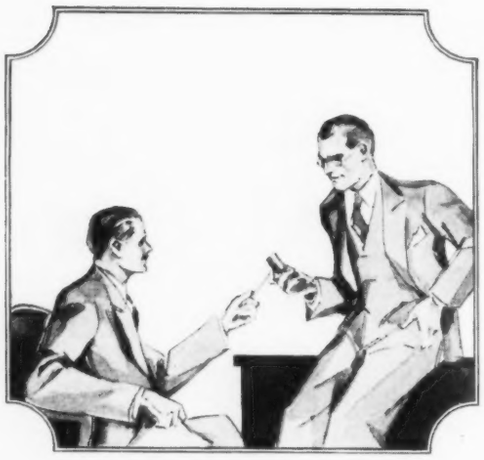
Gentlemen: Please send me a free sample of Douglas Fir Plywood, a copy of your Industrial Bulletin, and comparative test data.

*Name*_____

*Company*_____

*Address*_____

*City*_____ *State*_____



Your product can be improved *with* molded parts

966 makers of 35 electrical products selling to a Billion Dollar Market, use molded parts.

More molded parts enter into the construction of these products than any other component.

Have you investigated the important bearing Norloc might have in the improvement of your product?

The use of Norloc is not confined to the Electrical industry. More and more each day, the men who design and who put style into manufacturing, are calling upon our Engineers for help in the development of ideas.

Gas Ranges, or Jewel Cases, durability or beauty — in either case Norloc plays a paramount part.

NORTON
Laboratories, Inc.
Lockport, New York
DIV. 100

Write at once. We have solved the molding problems of many of the country's foremost industries. Get our analysis and constructive suggestions.

Norloc

Possibly You can use a Celluloid or Phenolic Compound Molded Part to *better advantage*

It may be on account of a particular color you wish to match—

Or the non-electrical conductivity of the material—

Or a certain physical characteristic of the compound—

Or the lightness of the material—

Or the low cost—

Or the unlimited manner in which it can be gracefully shaped and molded—

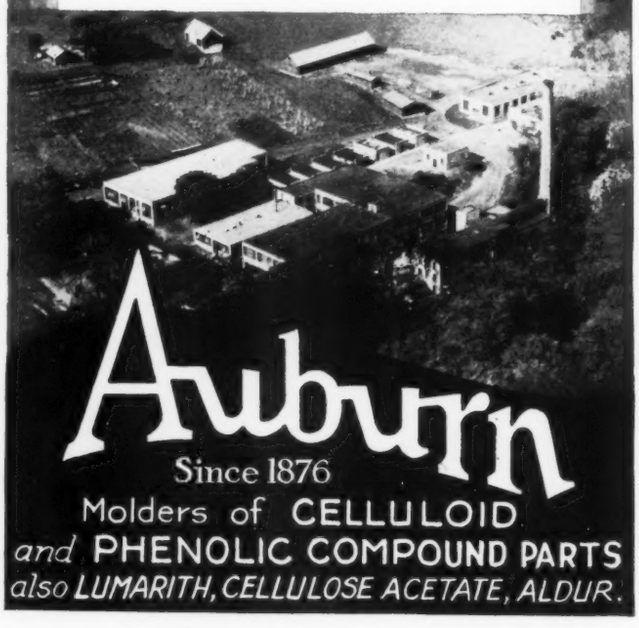
Or that you wish to eliminate costly machining.

Send for our literature on the subject—it is interesting.

Put your problems up to us.

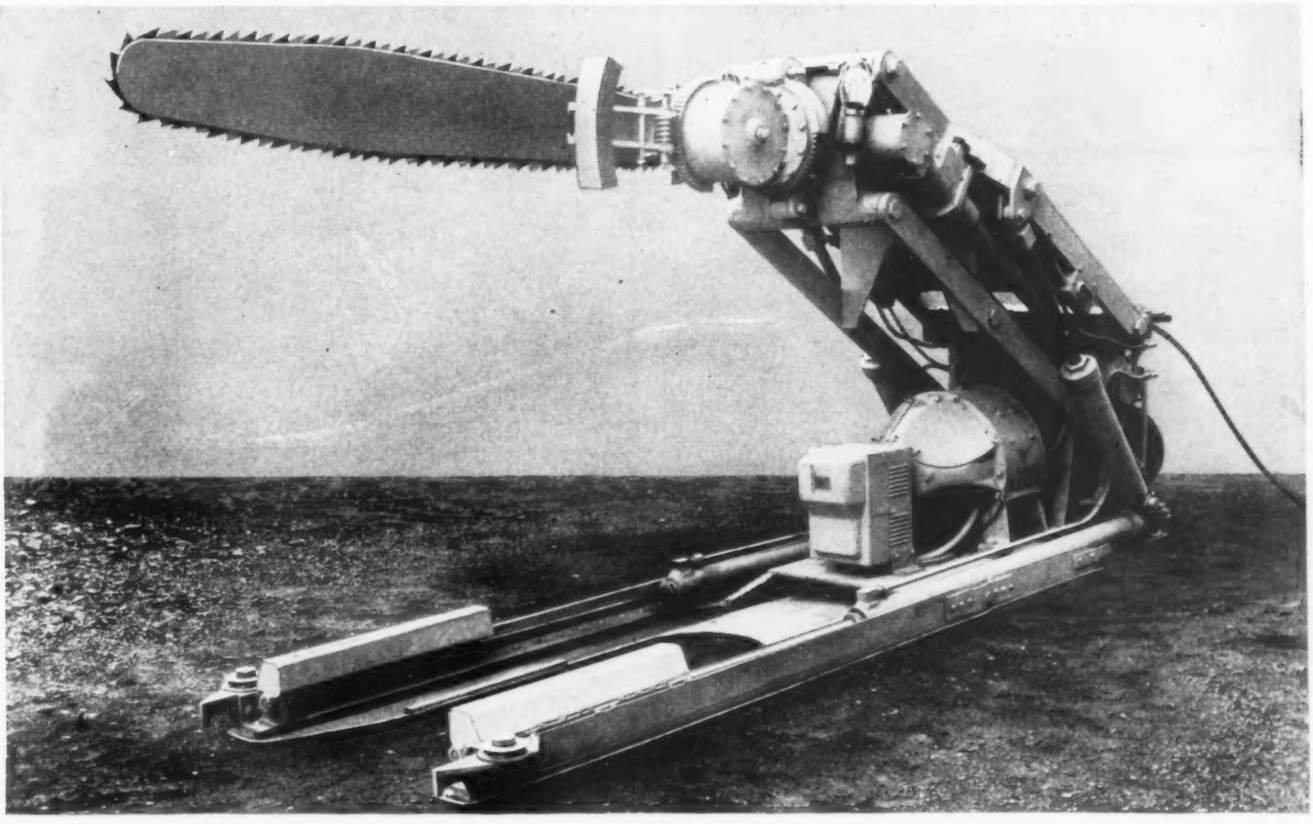
CELLULOID-BAKELITE DIVISION

AUBURN
BUTTON WORKS, Inc.
AUBURN, N. Y.



Auburn
Since 1876
Molders of CELLULOID
and PHENOLIC COMPOUND PARTS
also LUMARITH, CELLULOSE ACETATE, ALDUR.

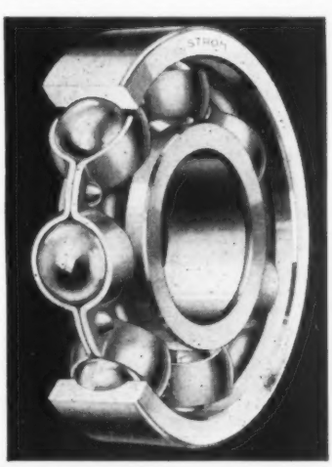
THIS INNOVATION *in* COAL SAWING



is completely equipped with
29 STROM BALL BEARINGS

WHAT a saw! Biting a long, horizontal cut at the top and bottom of the seam . . . following with two vertical incisions to form a solid block of coal, easily dislodged from the seam without the use of explosives. That's the way the new Joy Bros. Coal Saw does it.

Joy Bros. are old-time users of Strom Ball Bearings. They *know* Strom quality—having proved it in other types of Joy mining equipment. 29 Strom Bearings are used in their new Coal Saw . . . used because of their capacity—long life and ability to hold vital shafts in accurate location. Strom dependability starts with the basic quality of its raw materials . . . is added to by many exclusive design features . . . and terminates in the many tests and inspections that guard each part. You cannot afford to overlook Strom shaft protection that allows your equipment to run at top speed through its natural life . . . that never ties up production or runs up maintenance expense because of bearing wear or adjustments. Strom Bearings Co., Division of Marlin-Rockwell Corporation, 4535 Palmer Street, Chicago, Ill.



Strom BALL BEARINGS

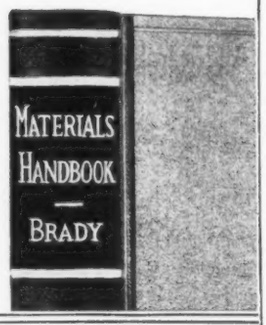
Your name stamped on this book FREE

At no additional cost to you, we will stamp your name, or a friend's name, in gold on the front cover of any copy of Brady's Materials Handbook ordered from this advertisement. This is a special Christmas offer, limited to acceptance before January 1, 1932.

—1526 material groups

—over 2400 materials described

—600 pages of daily usable data



Chief characteristics, comparative data, substitutes, sources—just the concise information you want, available in handy form at the time you want it. From authoritative sources, alphabetically arranged and indexed.

1931 Second Edition
Revised and Enlarged

Materials Handbook

by GEORGE S. BRADY

Managing Editor, *Product Engineering*
Associate Editor, *American Machinist*

600 pages, pocket size, flexible, $5.00

Just a few of the major group headings are:

Irons, steels, light alloys, corrosion-resistant metals, heat-resistant metals, molding materials, refractories, abrasives, brasses, bronzes, white metals, finishing materials.

The cost of the product depends on the properties and working characteristics of the materials used in it, just as does its satisfactory service in the hands of the user.

Brady's *new* Materials Handbook is the short cut to accurate, up-to-the-moment knowledge of what is suitable and where and why.

It is a book that every engineer will keep at hand and use continually.

Do you want to make a friend a gift combining personal thoughtfulness with real utility? Do you want a copy of Brady's Materials Handbook that you will doubly prize? Then take advantage of this free stamping offer. Send the coupon today. (Proper remittance should be enclosed with orders and, of course, stamped copies are not returnable.)

SPECIAL HOLIDAY OFFER COUPON

McGraw-Hill Book Company, Inc., 330 West 42d Street, New York.
Send me **Brady's Materials Handbook,** with name stamped in gold on the front cover. I enclose $5.00 and understand that stamped books are not returnable. (This offer expires Jan. 1, 1932.)

.....
(Name to be stamped. Please print)

Name .....

Address .....

City and State.....P.E. 12-31

The
WICKES
CONTINUOUS BLUE PRINT MACHINE

Perfect
Prints at new Low Costs

This machine will give you more prints per day at a lower cost per square foot. Each print will be a clear, perfect print.

Designed for the large or small drafting room—handles cut or continuous sheets up to 48-in. width. A new machine, automatic and simple in operation, it opens the way to important savings in blue printing costs. Write for full information today.

WICKES BROTHERS
522 No. Water St., Saginaw, Michigan, U. S. A.

ESTABLISHED 1856
1856—*75th Anniversary*—1931

Does Your Product Measure Up to Modern Demands?

If not — now is the time to take steps to

Improve its design
Increase its efficiency
Create additional markets
Lower your own shop costs

We have functioned for many years as engineering counselors to manufacturers in the development of new machines or products and the improvement of others.

We can help you to increase profits by rendering a complete advisory product engineering service that will enable you to make more profits.

May we talk it over? Write us for full details.

Manufacturers' Consulting Engineers

O. C. Kavle L. W. Moulton

McCarthy Bldg., Syracuse, N. Y.

"We CAN'T spoil it!"

The manufacturer had a hunch—*with surprising results!*

IT is an old hardware product—about as hard-boiled and matter-of-fact as any two-fisted workman's tool you can imagine.

Its maker had a hunch—"Why not identify our brand with COLOR? Maybe it will cost a little more—maybe extra sales will justify it."

So he called in some lacquer men—Egyptian among them. Now the lacquer was obviously going to wear off this particular tool once it got on the job. No stopping it. The other lacquer people got their samples in first. When the Egyptian man called back with *his* samples, the manufacturer was discouraged.

"No good," he said. "The lacquer gets sticky and the tool won't work cleanly."

With fear in his heart, the Egyptian man said, "Try these!" The foreman was called in. For a solid hour (and the salesman's hands grew clammy) the workman did not return. Then he came back, looking surprised. The tool showed the Egyptian lacquer worn, but dry as a bone and perfectly smooth. "We can't spoil it!" he declared.

And the funny part of this story is that with the Egyptian finish, Mr. Manufacturer avoids two costly finishing processes and decreases unit costs while increasing the salability of his product!

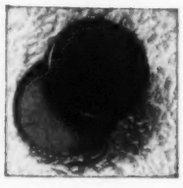
Maybe *your* hunch will be as profitable! It's worth calling in the Egyptian representative to find out. No obligation, of course. Just pick up your phone. "Egyptian Lacquer" is listed in the following cities:

ATLANTA	CINCINNATI	KANSAS CITY	SAN FRANCISCO
BOSTON	CLEVELAND	LOS ANGELES	SEATTLE
BUFFALO	DALLAS	PHILADELPHIA	SPOKANE
CHICAGO	DETROIT	PORTLAND, ORE.	ST. LOUIS

THE EGYPTIAN LACQUER MFG. CO.

90 WEST STREET · NEW YORK CITY

Smooth-Surface LACQUER FINISHING



PERMANENT *flexibility*—permanent adhesion. It's an old, old story for us. You see, we've been doing it since 1924. But regularly, we find that our finishing materials and their unusual properties hold the newness of new things to ever so many people.

So many firms are slow to change over to improved materials or methods. So many firms are just beginning to be interested in smooth, glowing color... *economically* applied. So many do not know that there are *flexible* lacquers for stamped and formed parts!

Every month, these advertisements locate for us a dozen or more individuals who have become freshly interested...and inquire for more data. Perhaps, *you* will find in the information we can present by mail, something which will be of assistance.

ROXALIN *Flexible* LACQUER CO., INC.
35-40 Thirty-Sixth St., Long Island City, N. Y.

Let us send you our newest color card showing the sixteen standard shades and their respective tints. These flexible *materials are also available as clear lacquers. We'll also send along a series of Research Bulletins giving helpful finishing data. These belong in your files where you can get at them.*

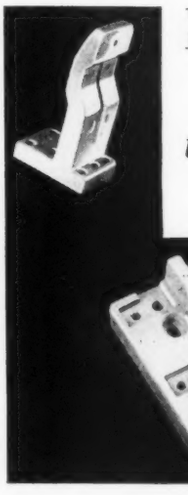
PORCELAIN ENAMEL & MFG. COMPANY
Pemco Avenue · Baltimore · Maryland · U. S. A.

"JOHN won't say what he's giving me for Christmas. I hope it's one of those new table-top ranges finished in Pemco Porcelain Enamel. Pemco Enamel is a Christmas gift every day of the year."

If you are designing a new product or redesigning an old one, write us for full particulars about preserving and beautifying its surface with Pemco Porcelain Enamel. If your product is made of iron or steel it can be porcelain enameled.

Write for a copy of our publication The AMERICAN ENAMELER

PEMCO
TRADE MARK REG. U.S. PAT. OFF.

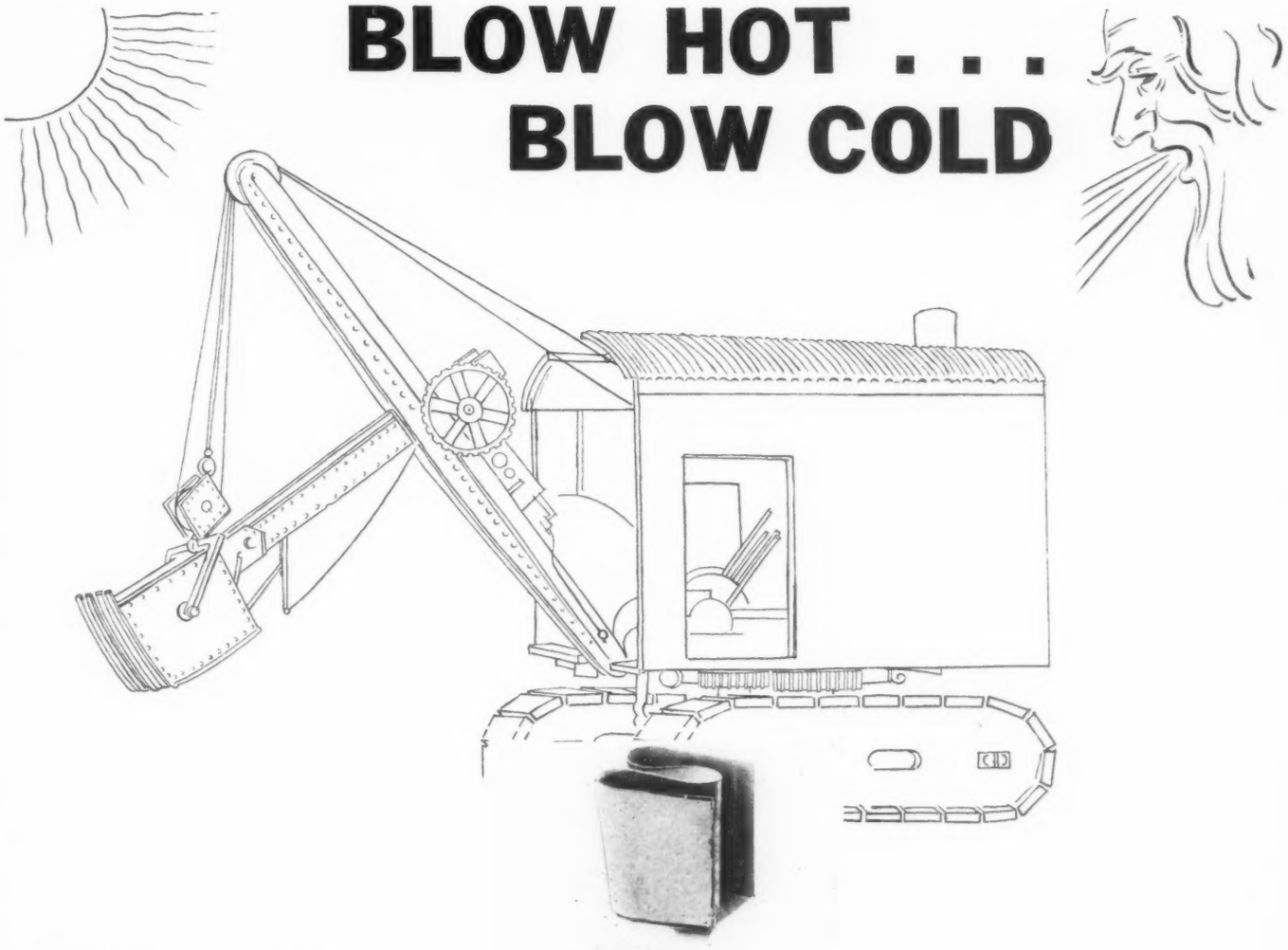


PORCELAIN
Engineered to meet your needs

Each job is engineered according to the use for which it is intended. Low absorption, strength, close dimensions, or other requirements can be obtained in Akron Porcelain. We will build your porcelain parts from your drawings and specifications to fit your needs. What are your requirements?

***The* AKRON PORCELAIN CO.**
AKRON, OHIO
Specialists in Porcelain

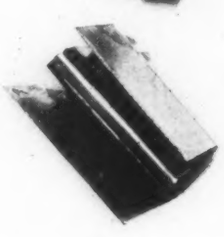
BLOW HOT . . . BLOW COLD



Be it young or old . . . a DULUX Finish flexes and adheres when surfaces expand or contract . . . shows 50% to 100% longer life in three-year tests.

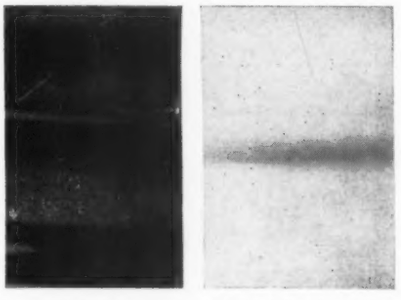
WHAT finish is harder than enamels and yet more flexible than paint? DULUX. And on your product, this property would mean greater durability and protection to surfaces. When surfaces respond to heat or cold, Dulux expands or contracts with them — not only when first applied, but even after aging. Have you ever heard of even a paint doing that? Yet Dulux is more difficult to scratch than enamels.

Three-year tests indicate Dulux lasts from 50% to 100% longer than paints, varnishes, or enamels. It is resistant to the action of the most destructive enemy of paints, the ultra-violet rays of the sun.



WE BENT THEM — These sheets of DULUX finished steel had been aged 1½ years.

Not only is Dulux flexible when first applied — but also after a long period of time, it is unequalled in flexibility by any type of enameled finish. It expands and contracts when wood and metal surfaces respond to heat or cold. These are unretouched photographs.



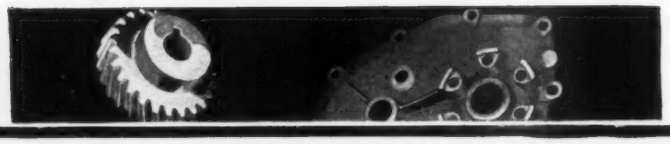
WE HAMMERED THEM STRAIGHT AGAIN — Not a crack, chip or break.

It is highly impermeable to moisture. It resists the action of acids, alcohol, and petroleum solvents. The Dulux vehicle is unaffected by temperatures as high as *350°F.*

Dulux is classed next to Duco and lacquers for quick drying. It is applied by spray or brush — baked or air-dried.

Old standards of product finishing are on the way out. The new standards of beauty and durability are those established by Dulux in three year tests. What are these? How do they affect your product? Du Pont will send you full information. Write E. I. du Pont de Nemours & Co., Inc., Industrial finishes division at Parlin, N. J., or Chicago, Boston, San Francisco. In Canada, Canadian Industries, Ltd., Toronto.

DUPONT REG. U.S. PAT. OFF. DULUX



CHANGE OVER TO DIE CASTINGS

Reap the benefits of lower production costs and greater sales appeal

DAY by day, more and more progressive manufacturers are turning to Newton Die Castings to reduce production costs, to increase sales, to reach a wealth of high objectives which only die castings can approach. For it is only the die casting process which turns metals into hundreds and perhaps thousands upon thousands of items, identical in dimension, intricate in shape and economical to produce.

Use more die castings, accept the advantage of their clean cut lines which demonstrate at a glance the high quality which lies within them. Use them as your strongest allies in new selling plans.

—and as a final word to sagacious buyers, use Newton Die Castings because they faithfully attain the qualities you are seeking. Why not talk over your problems with a Newton representative, he too, is interested in *your* sales success, yet there is no obligation for his work.

NEWTON
DIE CASTINGS

NDC-30

The Newton Die Casting Corp.
146 Munson Street
NEW HAVEN CONNECTICUT

A NEW MODEL? Let Bossert help you produce it.

The makers of this new No. 2 Type ZO motor starter naturally turned to Bossert for parts to meet exceptionally rigid specifications.

When the Electric Controller and Mfg. Co. designed a new motor starter they laid down rigid specifications. The starter had to be dust-tight, vapor-proof, extremely compact. The cover must be free from wrinkles and of uniform gauge so no weakness would develop.

Bossert was called in — and Bossert stampings solved the problem.

Manufacturers are more and more turning to Bossert when new models are up for consideration. Successful companies today are not satisfied with "good-enough" products. Bossert help in design or redesign —trim, accurate Bossert stampings are helping to increase sales and improve profits.

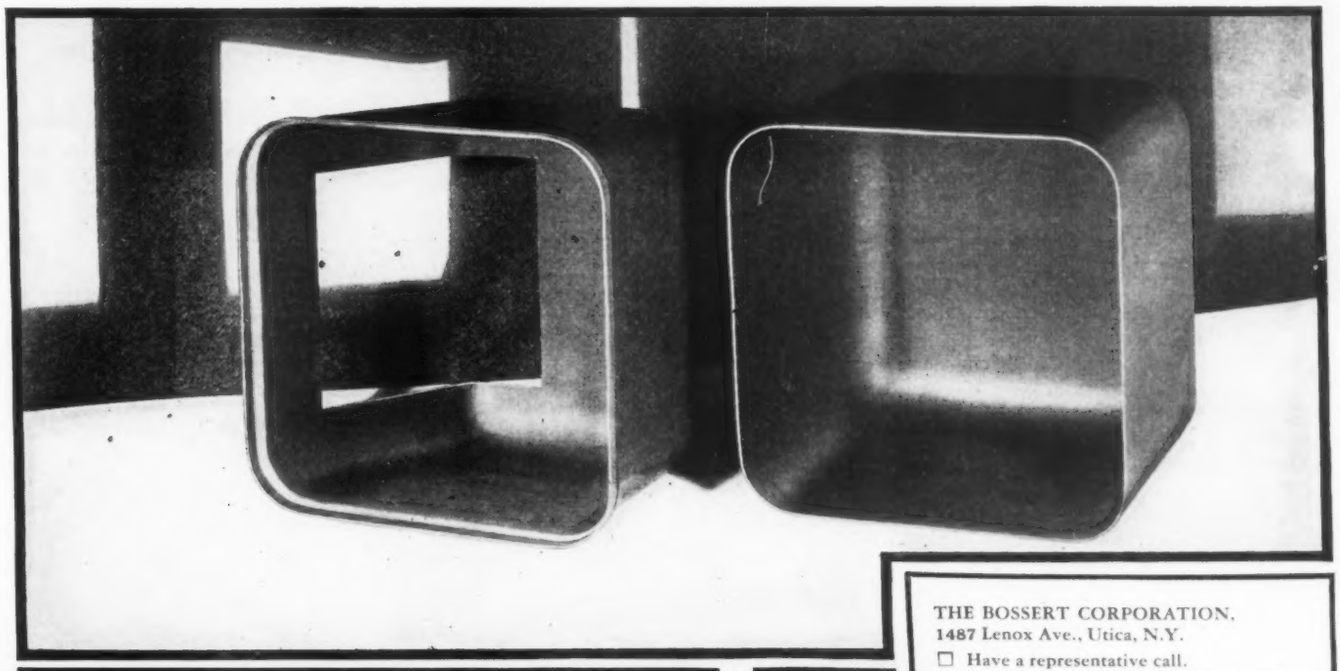
Lower Cost Often Results

These are days of keen competition, with cost an active factor. Bossert design and Bossert parts often mean reduced product cost, less assembly time, lower weight, elimination of costly machining. Perhaps Bossert can help you strengthen your position in your industry. Bossert engineers are available to consult with you on parts for new models, improvement of your product, or the possible saving in replacing present parts with Bossert Stampings. Write for a Bossert man to call by appointment. There is no obligation.

Send for the Bossert Booklet "Metal Stampings"

"Metal Stampings" outlines Bossert Service—design and production of large, medium or small stampings, welding, plating, polishing, assembly. Write for it.

THE BOSSERT CORPORATION
1487 Lenox Avenue Utica, New York
New York Cleveland Detroit



BOSSERT STAMPINGS

THE BOSSERT CORPORATION,
1487 Lenox Ave., Utica, N.Y.
☐ Have a representative call.
☐ Send the booklet "Metal Stampings"

Name .....
Company .....
Address .....

Making Ends Meet

and then some—Profit

Investigate paying applications

Veeder-Root INCORPORATED
HARTFORD, CONN.

VICTOR GASKETS for— MACHINERY BUILDERS

The World's Standard Gasket

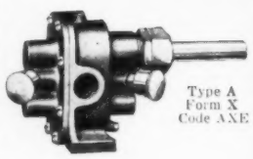
Made of copper-asbestos, Victorite (fibrous packing), cork, compressed sheet asbestos, felt, etc. . . . . World's largest exclusive manufacturers of Gaskets and Gasket Materials.

VICTOR GASKET & MANUFACTURING CO. ... 5750 Roosevelt Road, Chicago, U. S. A.

TO GIVE an ever widening circle of humanity the benefits of Modern Scientific Progress is the result of the Product Engineer's work.

OBERDORFER GEAR PUMPS

THE experience of Oberdorfer Pump engineers is at your service whenever you are confronted with a pump problem. The standard Oberdorfer line includes gear and centrifugal pumps of non-corrosive bronze in a full line of sizes. Special pumps can be made to meet your requirements.



Type A
Form X
Code AXE

Send for full data.

M. L. OBERDORFER BRASS COMPANY
2302 Thompson Road, Syracuse, N. Y.

MADE OF NON-CORROSIVE BRONZE

A Better Oil Seal for All Applications

Gits Precision Oil Seals Operate with Minimum Friction

Engineering Service Without Obligation Catalog on Request

Gits Precision Oil Seal

Will retain lubricant of all kinds and exclude moisture, dirt, and foreign matter from your bearings.

GITS BROS. MFG. CO.

1846-62 S. Kilbourn Ave. Chicago, Ill.

There is a Bassick Caster *for Every Type of portable equipment*

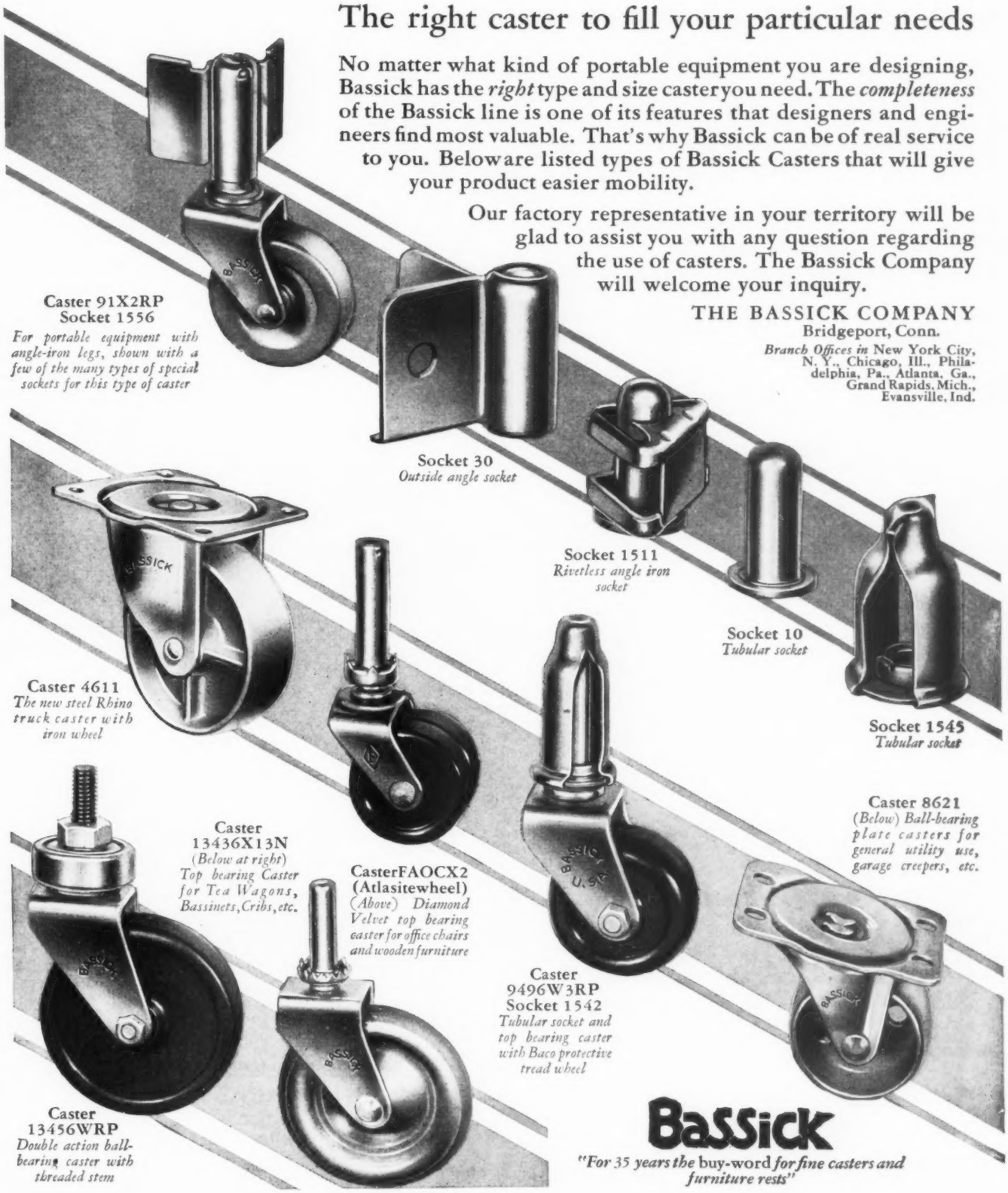
The right caster to fill your particular needs

No matter what kind of portable equipment you are designing, Bassick has the *right* type and size caster you need. The *completeness* of the Bassick line is one of its features that designers and engineers find most valuable. That's why Bassick can be of real service to you. Below are listed types of Bassick Casters that will give your product easier mobility.

Our factory representative in your territory will be glad to assist you with any question regarding the use of casters. The Bassick Company will welcome your inquiry.

THE BASSICK COMPANY
Bridgeport, Conn.

Branch Offices in New York City, N. Y., Chicago, Ill., Philadelphia, Pa., Atlanta, Ga., Grand Rapids, Mich., Evansville, Ind.



Caster 91X2RP
Socket 1556
For portable equipment with angle-iron legs, shown with a few of the many types of special sockets for this type of caster

Socket 30
Outside angle socket

Socket 1511
Rivetless angle iron socket

Socket 10
Tubular socket

Socket 1545
Tubular socket

Caster 4611
The new steel Rhino truck caster with iron wheel

Caster 13436X13N
(Below at right) Top bearing Caster for Tea Wagons, Bassinets, Cribs, etc.

CasterFAOCX2 (Atlasitewheel)
(Above) Diamond Velvet top bearing caster for office chairs and wooden furniture

Caster 8621
(Below) Ball-bearing plate casters for general utility use, garage creepers, etc.

Caster 9496W3RP
Socket 1542
Tubular socket and top bearing caster with Baco protective tread wheel

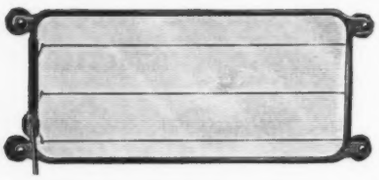
Caster 13456WRP
Double action ball-bearing caster with threaded stem

Bassick

"For 35 years the buy-word *for fine casters and furniture rests"*

SCRANTON BUTTON — FOR 50 YEARS — BRAND

YOUR PRODUCT
IN PART OR "PART AND PARCEL"
CAN BE IMPROVED IF A. R. C. MOLDED



This Electric Sleet-Frost Shield

employs an

A. R. C. MOLDED
Insulated End Cover
and Knobs

The unusual qualities of A. R. C. Moldings make them particularly adaptable for many uses, as a product in its entirety or as an individual part of a product. Our vast facilities, with a background of more than half a century's experience, make it especially advantageous to have your requirements A. R. C. molded.

The opportunity to quote from your prints or specifications will be welcomed.

AMERICAN RECORD CORPORATION
ARC
SCRANTON, PA.

NEW YORK: 1776 Broadway 645 Washington Blvd., CHICAGO
DETROIT: 145 Eastlawn Ave. 4900 Euclid Bldg., CLEVELAND
HOLLYWOOD, CAL.: 933 Seward St.

EFFICIENCY—
COMPACTNESS—
ADAPTABILITY—

These are the Three outstanding features of the PULLMORE Clutch, which after rigid tests led to its adoption as standard on a great variety of machinery.

If you are looking for a clutch of unusual merit to improve your product, let us work with you. A trial installation would convince you, and there would be no obligation.

WRITE FOR OUR CATALOG

ROCKFORD DRILLING MACHINE COMPANY
12 Catherine St., Rockford, Ill.

COMPLETE DIE CASTING SERVICE

From drawings to ~

finished die-castings, to your assembly floor in the shortest possible time. That is how thoroughly Franklin Service covers your die-casting needs.

Engineering advice. . . .design assistance. . . .in short, all aid offered by Franklin Service is backed by experience gained in producing *tons* of quality die-castings.

Let Franklin Die-Cast "It" and you will save time in machining and in assembling.

A request for an estimate causes no obligation. Send samples or drawings today!

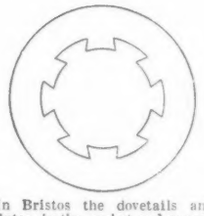
Quotations made on Nickel, Butler, or Chromium plating and Enamel.

FRANKLIN DIE CASTING CORP.
812 Gifford St., SYRACUSE NEW YORK
PERMANENT MOULD & DIE CASTINGS

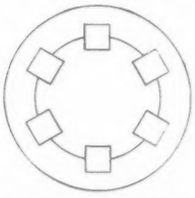
Set 'em up fast....and tight....no fear of slipping!

For fast assembling or for constant adjustment of machinery, no screws like Bristos. The flutes of the wrench *key* into the flutes of the socket. You can't slip and skin your hands as long as the wrench is in place. Neither can you flare or split the socket, for the strain is *keyed in toward the center* instead of toward the outside.

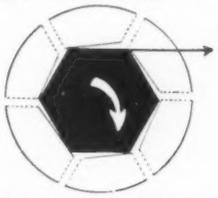
With this almost integral grip on the screw, Bristos can be set up quicker and tighter than any set screws you have ever used. This applies to all Bristo Cap and Set Screws, from the big inch and a half size on down to the smallest, no bigger than a match head!



In Bristos the dovetails and flutes in the socket and wrench interlock for a perfect grip.



The Bristo wrench holds the screw as positively as tho it were designed for keys.



Hex and square sockets wear out quickly from pressure on the walls of the socket.

For operations requiring continuous setting and resetting of drills, chucks, cutting tools, etc., try replacing your present screws with Bristos; the saving will soon show on your time records.

For fast, fussy assembling, Bristos are also a big economy; and the trim, inviting look they impart to a product actually increases sales.

Let us send you sample Bristos for test. Just tell us what sizes you want and how many. No charge; glad to do it.

Bristo Screws may be had with either regular or Dardelet threads.

better set screws - - - - - better products

Bristo "SAFETY SET" SOCKET HEAD CAP Screws

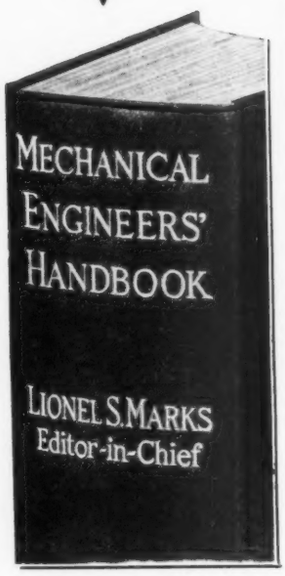
MANUFACTURED BY THE BRISTOL COMPANY, WATERBURY, CONNECTICUT

Your name stamped on this book FREE

At no additional cost to you, we will stamp your name, or a friend's name, in gold on the front cover of every copy of **Marks' Mechanical Engineers' Handbook** ordered from this advertisement. This is a special Christmas offer, limited to acceptance before January 1, 1932.

Third Edition

MARKS' Mechanical Engineers' HANDBOOK



NEARLY 300 pages larger than the second edition—every section thoroughly revised—many sections completely rewritten—many new sections—more contributors—more detailed, specialized treatment—finer subdivision of topics and closer indexing—these are but a few of the many features of this great new third edition.

In preparing this edition Professor Marks has had the assistance of 75 specialists. Marks has been brought right up to date—more than ever before it is the indispensable handbook for every engineer and designer.

2263 pages, 4½ x 7, over 1300 illustrations and diagrams, thumb-indexed, flexible binding, $7.00

Marks brings you latest data and practice in:

1. Mathematical. Tables, Weights and Measures.
2. Mathematics.
3. Mechanics of Rigid Bodies, Stresses in Framed Structures. Friction, Hydraulics.
4. Heat.
5. Strength of Materials.
6. Materials of Engineering.
7. Fuels and Furnaces.
8. Machine Elements.
9. Power Generation.
10. Hoisting and Conveying.
11. Automobiles, Railway Engineering, Marine Engineering, Aeronautics.
12. Building Construction and Equipment.
13. Machine Shop Practice.
14. Pumps and Compressors.
15. Electrical Engineering.
16. Measuring Instruments. Surveying, Mechanical Refrigeration, A. S. M. E. Power Test Codes.

Do you want to make a friend a gift combining personal thoughtfulness with real utility? Do you want a copy of Marks that you will doubly prize? Then take advantage of this free stamping offer. Send the coupon today. (Proper remittance should be enclosed with orders and, of course, stamped copies are not returnable.)

SPECIAL HOLIDAY OFFER COUPON

McGraw-Hill Book Co., Inc., 330 West 42d Street, New York City

Send me Marks' Mechanical Engineers' Handbook, with name stamped in gold on the front cover. I enclose $7.00 and understand that stamped books are not returnable. (This offer expires Jan. 1, 1932.)

.....
(Name to be stamped. Please print.)

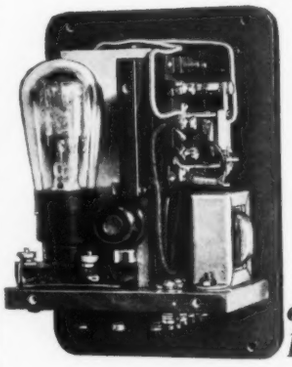
Name .....

Address .....

City and State .....

P.E. 12-31

NEW LOW PRICE FOR A LIGHT SENSITIVE CELL UNIT



Built to the same quality that has made Dunco Relays used the country over. . . .

THIS new light sensitive cell unit has the features you would expect in a unit costing more than twice as much.

It is neatly housed in an aluminum finished case, 6 x 5 x 3 in., and operates on standard voltage, 110 volt, 60 cycles. Special units, both AC. and DC. operated can be supplied for other voltages; standard UX 112-A radio tube is used, but not supplied with the unit, which lists at only $30.

Immediate deliveries will be made and circuit diagrams will be sent promptly upon request.

STRUTHERS DUNN, INC.
146 N. JUNIPER ST. DUNCO PHILADELPHIA, PA.

Put your motorization problems up to ZOBELL

Regard us as *your* motor department, and let us shoulder any problems in connection with the motorization of your product. Zobell engineers are motor specialists and are equipped to make a study of your particular problems. Their recommendations will definitely lead you to greater savings and increased profits.

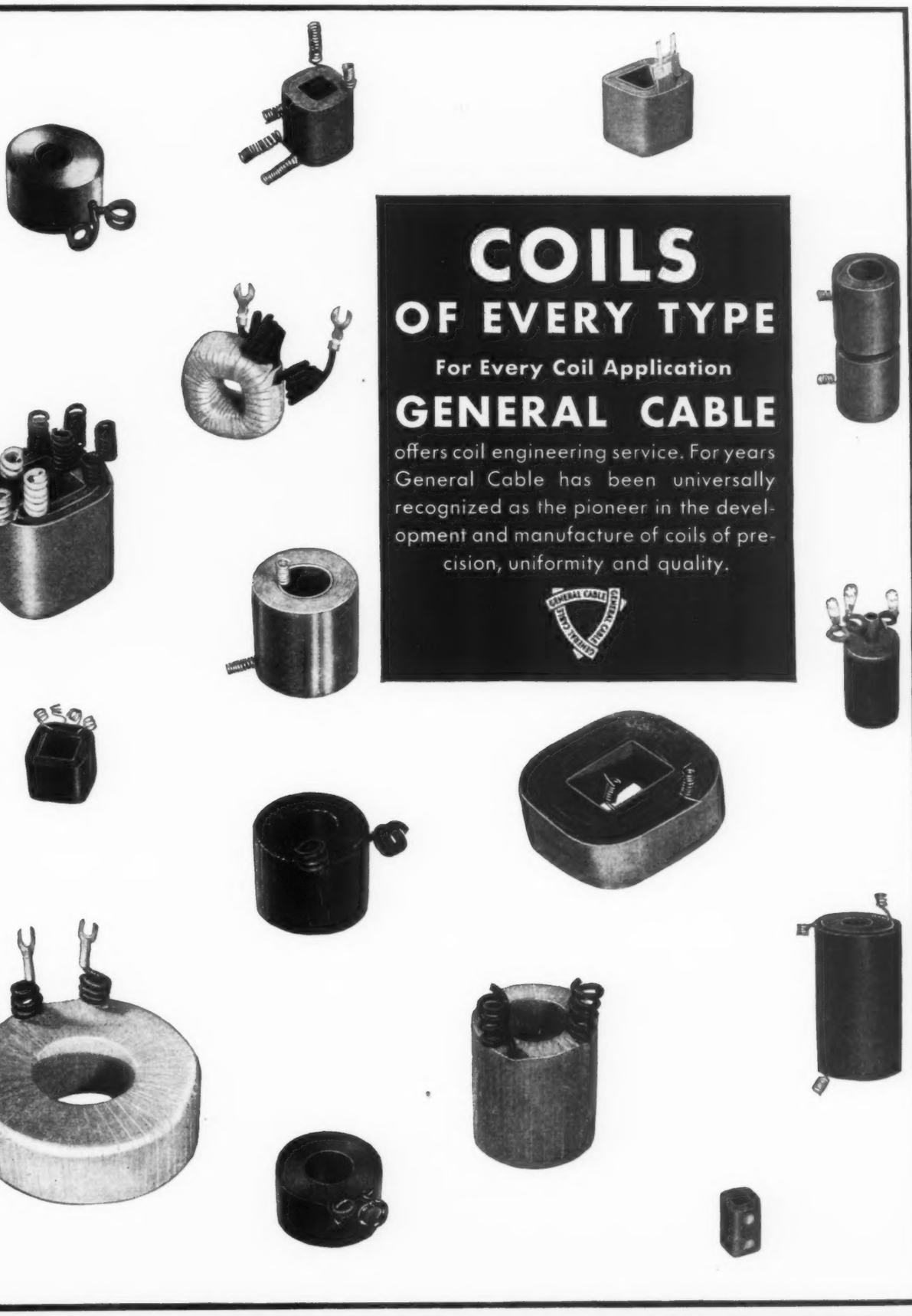
The Zobell Line of Semi-high and High Torque motors are ideal for such applications as dumbwaiters, presses, power shears, hoists, conveyors, etc.

Get acquainted with this Zobell service—get a Zobell bid—it defies competition!

Zobell Motors are made in sizes from ¾ to 7½ hp. D.C. and polyphase A.C.

ZOBELL ELECTRIC MOTOR CORPORATION
GARWOOD, N. J.

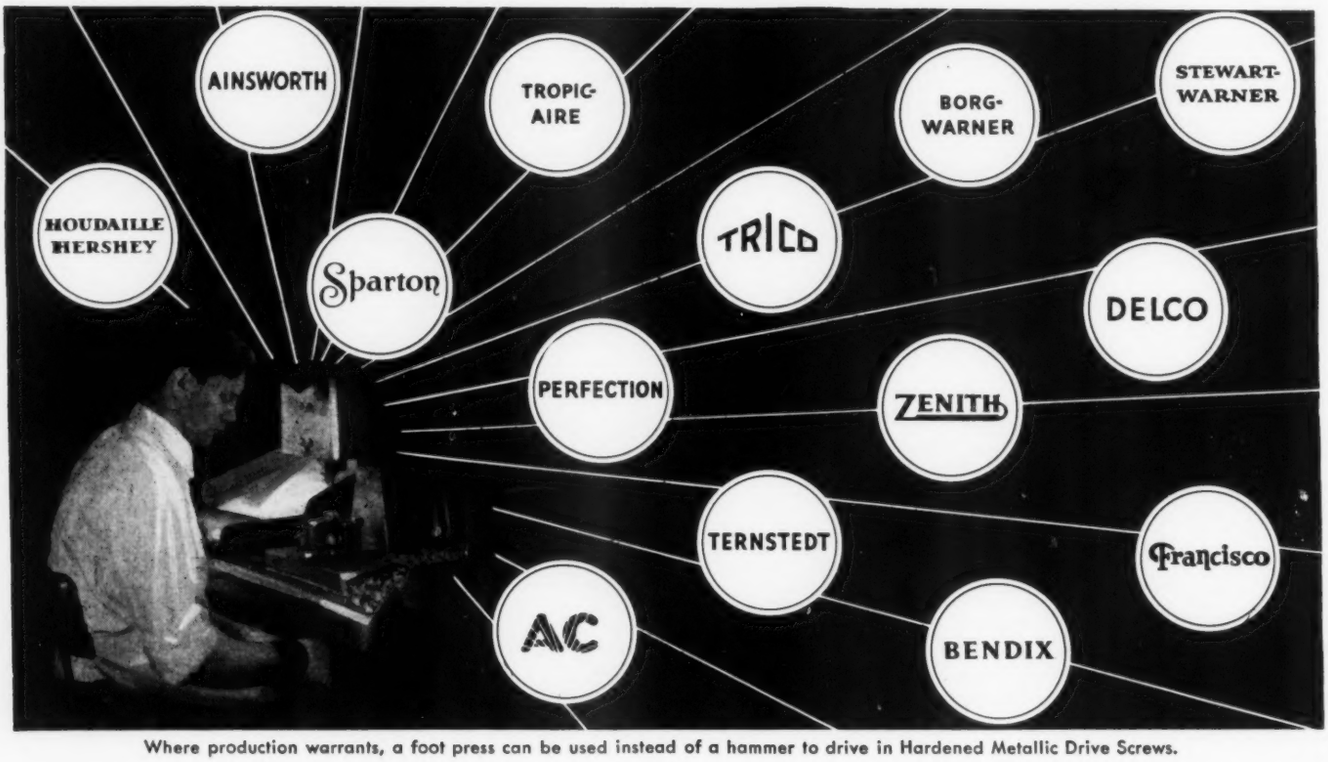
ZOBELL HIGH TORQUE MOTORS


COILS
OF EVERY TYPE
For Every Coil Application
GENERAL CABLE
offers coil engineering service. For years General Cable has been universally recognized as the pioneer in the development and manufacture of coils of precision, uniformity and quality.

GENERAL CABLE CORPORATION

EXECUTIVE OFFICES: 420 LEXINGTON AVENUE, NEW YORK • CONSULT OUR NEAREST OFFICE

MAKERS OF AUTO ACCESSORIES FIND WAY TO CUT ASSEMBLY COSTS AND IMPROVE QUALITY



Where production warrants, a foot press can be used instead of a hammer to drive in Hardened Metallic Drive Screws.

Self-tapping Screws provide cheaper, more secure fastenings

Accessory manufacturers are called upon to follow suit when automobile manufacturers offer greater and still greater value for less money. Prices have to be constantly reduced, yet quality must be maintained. To accomplish this, makers of auto accessories take advantage of every possible production economy. In assembly work they turn to the easiest, quickest, cheapest method that is consistent with security . . . Self-tapping Screws.

The above exhibit of concerns who use Self-tapping Screws for making assemblies is convincing testimony to the worth of these Screws. And even more convincing are the results which Self-tapping Screws have produced for those manufacturers. For example, one user reduced fastening costs 44 per cent, saving $25,321 a year on assemblies formerly made with machine screws. Another cut costs on a carburetor assembly by 36.6 per cent. Assemblies were strengthened, too. Unbiased tests prove that Self-tapping Screws actually make stronger fastenings than the devices which they usually replace.

If you make metal assemblies...and wish to make them better and more economically, find out what Self-tapping Screws will do on your work. Our Assembly Engineers will tell you. Just attach a description of one or more assemblies when you return the coupon for the informative booklets shown below.

Type "Z" Hardened Self-tapping Sheet Metal Screws
For joining and making fastenings to sheet metal up to six gauge; also aluminum, die castings, Bakelite, etc. Simply turn Screw into drilled, pierced or molded hole. It forms a thread in the material as it is turned in. Can be removed and replaced.

Type "U" Hardened Metallic Drive Screws
This type of Self-tapping Screw is used for making permanent fastenings to iron, brass and aluminum castings, steel, Bakelite, Durez, etc. Just hammer the Screw into a drilled or molded hole. It forms a thread in the material as it is driven.

PARKER-KALON *Hardened* Self-tapping Screws

PAT. IN U. S. AND FOREIGN COUNTRIES

← 14 Unbiased Reports on Savings ---------- Scientists Explain Fastening Security →

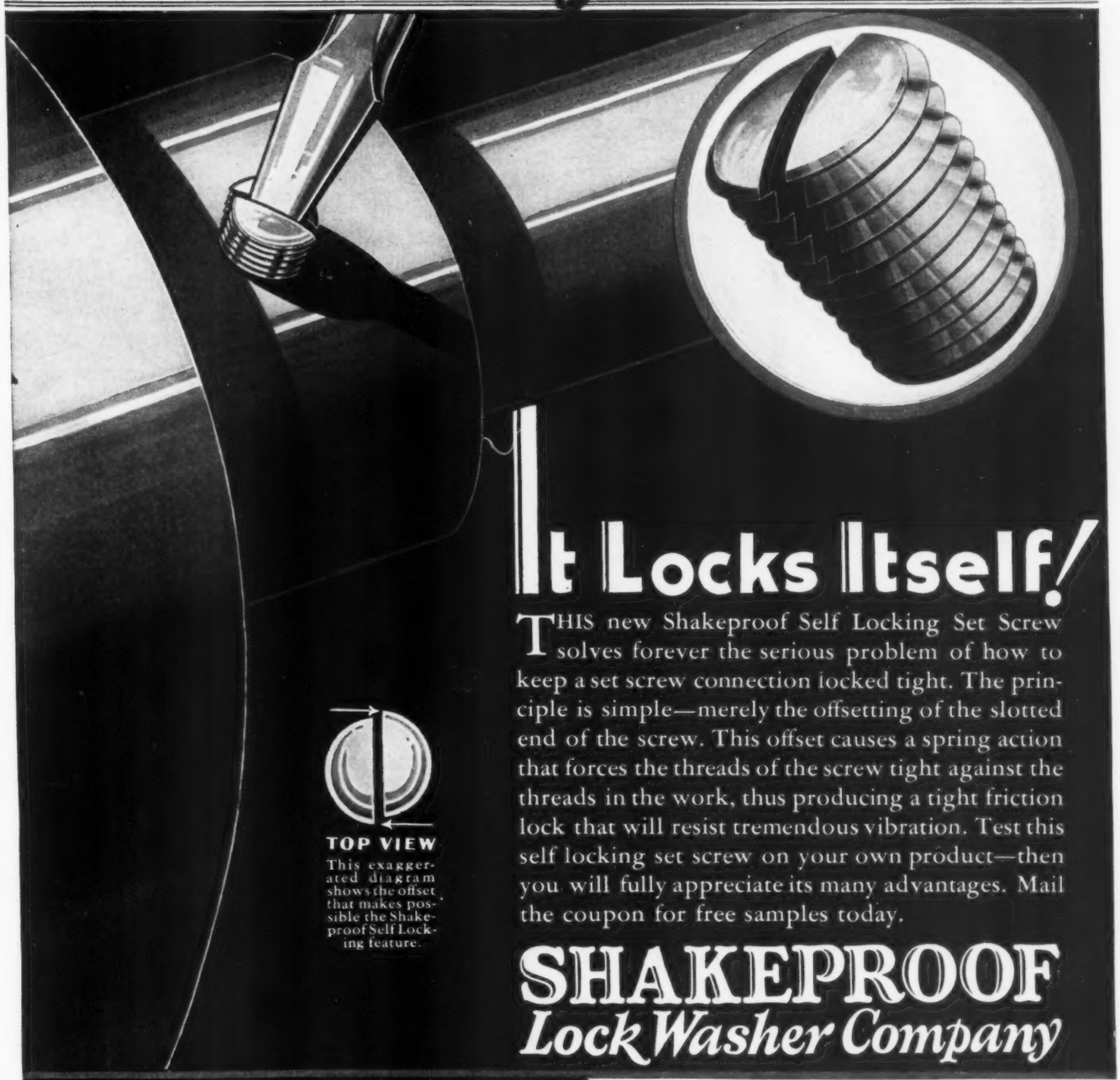
PARKER-KALON CORPORATION, Dept. P, 198-202 Varick Street, New York, N. Y.

Tell us whether Self-tapping Screws can be used to advantage for assemblies described on attached sheet. Also send booklets on the Security and Economy of Assemblies made with Self-tapping Screws.

Name and Co. _____

Address _____

SHAKEPROOF
Self Locking Set Screw



It Locks Itself!

THIS new Shakeproof Self Locking Set Screw solves forever the serious problem of how to keep a set screw connection locked tight. The principle is simple—merely the offsetting of the slotted end of the screw. This offset causes a spring action that forces the threads of the screw tight against the threads in the work, thus producing a tight friction lock that will resist tremendous vibration. Test this self locking set screw on your own product—then you will fully appreciate its many advantages. Mail the coupon for free samples today.

TOP VIEW

This exaggerated diagram shows the offset that makes possible the Shakeproof Self Locking feature.

SHAKEPROOF
Lock Washer Company

Shakeproof representatives are located in the following cities:

New York City Philadelphia Boston Pittsburgh Schenectady Cleveland Detroit Toledo Cincinnati Milwaukee Los Angeles Birmingham, Ala. Seattle Dallas, Texas San Francisco Toronto, Ontario, Canada

Mail This Coupon To-Day

COUPON

SHAKEPROOF LOCK WASHER CO.
(Division of Illinois Tool Works), 2549 N. Keeler Ave., Chicago, Ill.

Gentlemen: We want to test your new Self Locking Set Screw. Please send us samples as indicated.

Style of Point..... *Size*.....

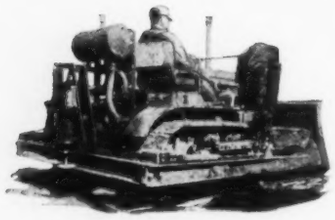
Firm Name.....

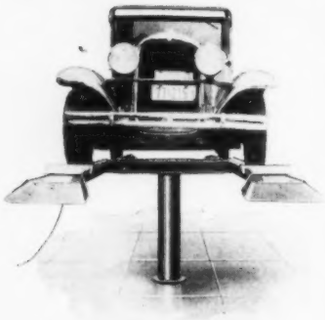
Address.....

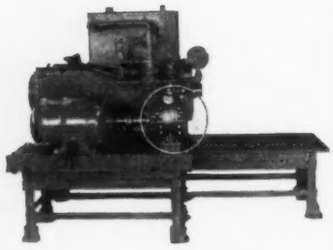
City..... *State*.....

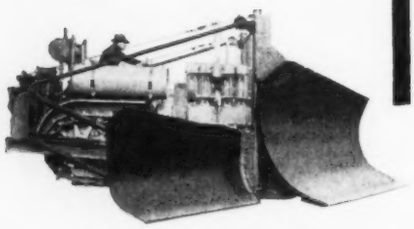
By..... *Title*.....

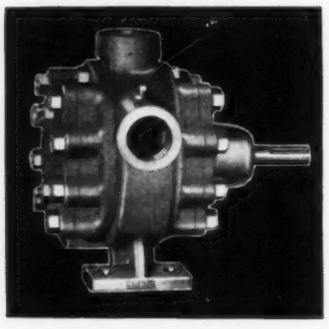
ROPER
Pressure Pumps







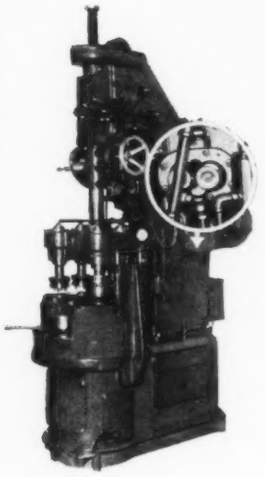


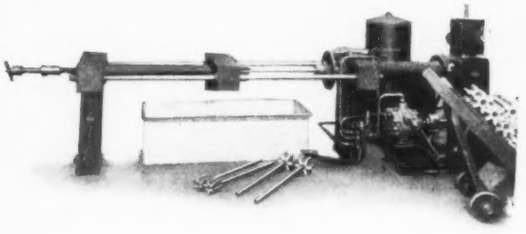


The HEART of POWER

for HYDRAULIC power transmission

Built solely for hydraulic work — not merely old models made tighter to hold pressure and then labelled "hydraulic." Roper never builds "down to a price" — always up to a high quality and service standard. ● Most simple of pump designs . . . rotary gear principle — only two working parts. Fewer parts to wear — longer life — minimum care — less replacement expense. ● Constructed from materials best suited to each hydraulic job, as revealed by 75 years of pump building plus a research and testing laboratory second to none in the hydraulic pump field. No speculation on metals — tested *first*, then adopted. Most Roper pressure pumps are just "wearing in," when others start wearing out. ● Manufactured by pioneers in the hydraulic power transmission field. Roper engineers have discovered new hydraulic applications, devised new hydraulic mechanisms, and developed new hydraulic pumps which are now used on many and varied machines and equipment. Perhaps one of these products is similar to yours. ● Get all the facts now — write for folder "THE HEART OF POWER." Free engineering help, if desired. Address Geo. D. Roper Corp., Rockford, Ill.





GEO. D. ROPER CORP., Rockford, Ill.

Philadelphia - Chicago - Dallas - San Francisco

ONLY MORSE COUPLINGS CAN GIVE YOU THESE FEATURES

Coupling halves easily installed. Note simplicity of construction.

Guide links fit groove in one-half, keeping chain in place.

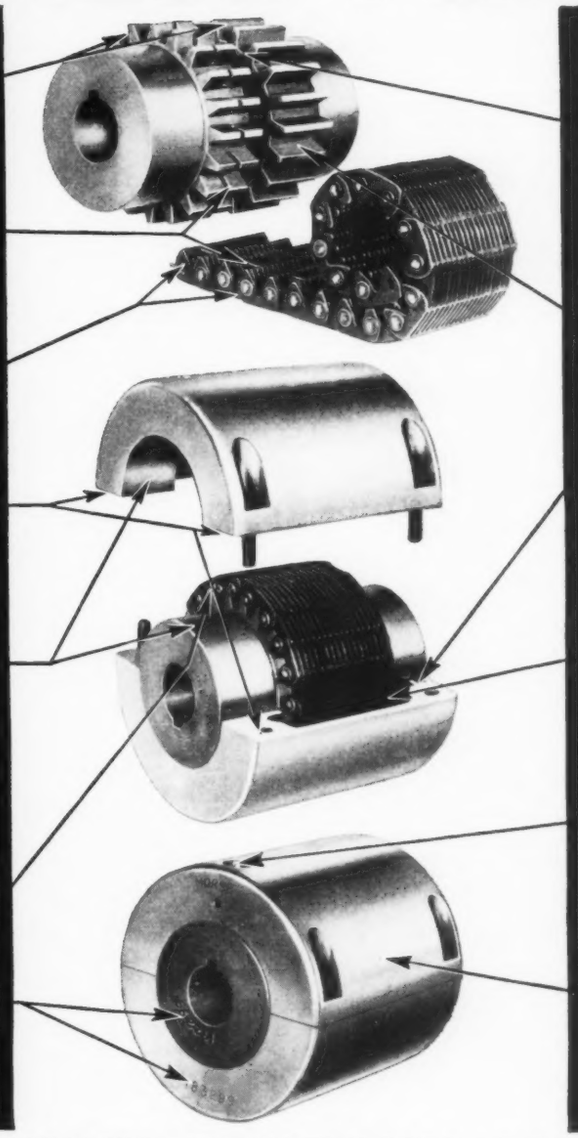
Coupling easily disconnected by removing chain.

Tight seal here insured by ground surfaces and gasket between halves.

Accurately ground fit between case and hub supports case on this half of coupling. Felt grease retaining ring on opposite end allows flexibility.

Easily accessible cotter pin facilitates removal of chain connecting pin.

Number on cover and coupling hub for ready reference.



Alignment is easy due to these finished flat surfaces. Morse simple construction permits removal of either half.

Smooth teeth on this half permit free end float.

Felt grease and dust seal here.

Space to be entirely filled with light grease when installing.

Zerk fitting for additional lubricant.

Entirely enclosed, dust proof, oil tight, all metal coupling.

MORSE CHAIN COMPANY, Ithaca, N. Y.

Branches in Principal Cities

Morse Chain Co., Ltd. Letchworth, Herts, England

Division of Borg-Warner Corporation

Manufacturers of Morse Silent Chain Drives, Morse Roller Chain Drives, and Morse Flexible Couplings

MAIL COUPON FOR FLEXIBLE COUPLING BULLETIN NO. 47

P.E. Dec., 1931

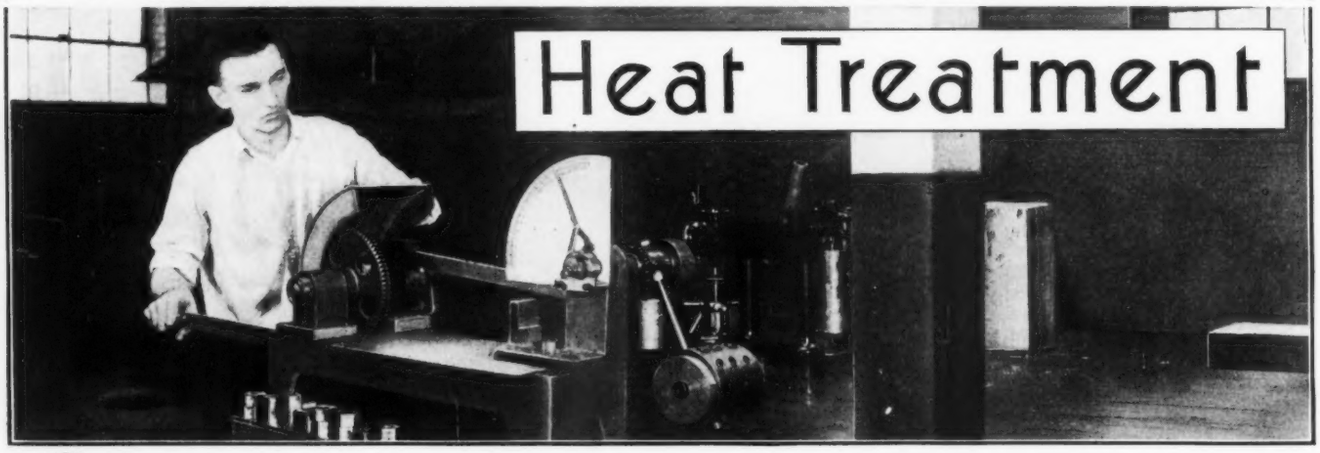
MORSE CHAIN CO., Ithaca, N. Y.

Please send me a copy of Morse Flexible Coupling Catalog, Bulletin No. 47.

Name..... Firm.....

Address..... City..... State.....

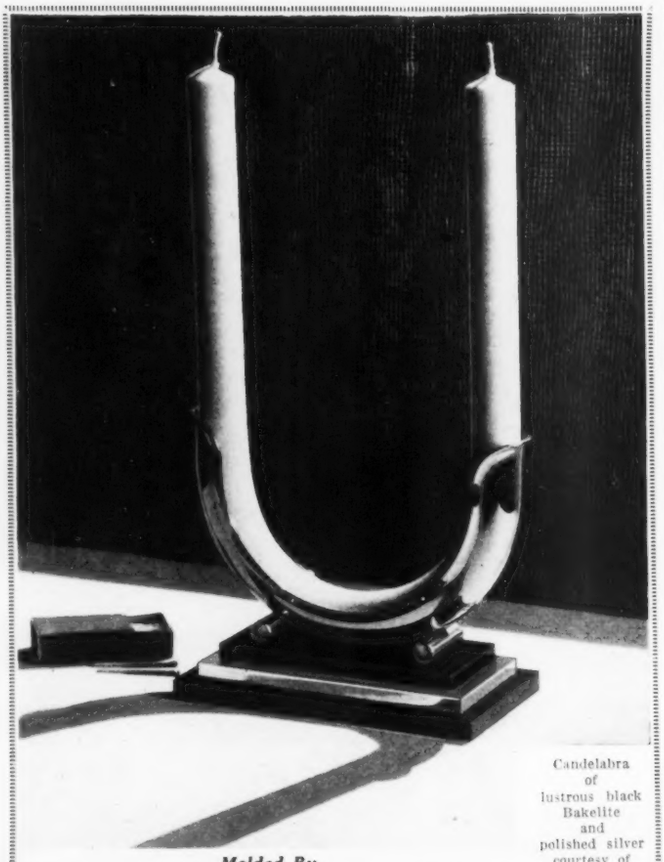
No. 5 of a Series ALLEN TEST OPERATIONS



SAMPLES of every lot of the screws are subjected to readings on Rockwell Hardness Tester and Allen Torsional Testing Machine. Heat treatment is so regulated that the screws will have a hardness varying not more than plus or minus 4 points on the C Rockwell screw. In the torsional tester, pressure bears on the wrench same as when pull is applied by hand in tightening the screw to its work. Inch-pounds resistance at the breaking-point is accurately measured and each heat of the product held to the Allen standard. Let us forward samples for your own tests.

THE ALLEN MFG. COMPANY

HARTFORD, CONN. U. S. A.



Candelabra of lustrous black Bakelite and polished silver courtesy of Dole Valve Co.

Molded By

CHICAGO MOLDED PRODUCTS CORP.

2141 Walnut St. Chicago, U. S. A.

"Naturally, special requirements need the counsel of a specialist * * *"

Quoted from an article in the October issue of *Product Engineering*

There are so many technical subjects the product engineer must know something about that he is unlikely to be expert in more than a few.

This might prove a serious handicap if it were not for the fact that experts in the other lines are available as consultants. For professional services related to product engineering see the "Professional Services" cards on page 61.

SEARCHLIGHT SECTION

POSITION WANTED

MECHANICAL engineer, 40, German, married. 8 years in U. S., 22 years' broad varied experience, research, experimenting, developing, designing of miscellaneous electrical and mechanical machinery, machine shop and production experience, excellent references. PW-11, Product Engineering, 330 West 42d St., New York.

PART TIME WORK WANTED

PATENT attorney, chemical engineer, in charge patent department of Eastern manufacturer offers part-time services to firm or corporation. PTW-10, Product Engineering, 330 West 42nd St., New York.

This— is as important as That

THE very fact that any Spring is required is indicative that that particular Spring is important. Working on this supposition, the Wickwire Spencer Steel Company gives the same care and attention to filling the small order of a few little Springs as it does to the one that calls for thousands of Springs of more pretentious dimensions. Every Spring and Formed Wire produced by this company is considered an important matter and is treated with due consideration.

WICKWIRE SPENCER STEEL COMPANY
41 East 42nd Street, New York City

WICKWIRE SPENCER
SPRINGS & WIRE FORMS

Just published

The first of the

ENGINEERING SOCIETIES MONOGRAPHS

Dr. A. Nádai's PLASTICITY

The series of ENGINEERING SOCIETIES MONOGRAPHS has been created for the presentation of books selected by four national engineering societies, and adjudged to possess usefulness for engineers or industry, but not likely to be published commercially.

PLASTICITY

A Mechanics of the Plastic State of Matter

by A. Nádai, Dr. Ing.,

Research Laboratories of the Westinghouse Electric and Mfg. Company; Member, Faculty of Graduate School, University of Pittsburgh; formerly, Professor of Applied Mechanics, University of Goettingen, Germany

assisted by A. M. Wahl

Research Laboratories of the Westinghouse Electric and Mfg. Company

350 pages, 6x9, revised and enlarged from the German edition $5.00

THIS book presents for engineers and designers the fundamentals of the theory of plastic flow in materials, especially in the metals. It is concerned with one important part of the theory of strength of materials and is based on the best methods of engineering mechanics and on the most up-to-date results of laboratory tests. It embodies the author's experiences of nearly ten years at the Institute of Applied Mechanics of the University of Goettingen, where the applied sciences under Felix Klein and L. Prandtl have been so highly developed, as well as his experiences for three years in his connection with the Research Laboratories of the Westinghouse Electric and Manufacturing Company.

The book, based on the original German edition, but amplified and enlarged by the addition of new information, brings together the observations of engineers, metallurgists and physicists regarding the plastic deformations of metals and then summarizes the laws which in the present state of knowledge are available, for the more exact prediction of the distribution of stress.

Nádai's PLASTICITY will be sent on approval for 10 days, on receipt of the coupon below.

McGRAW-HILL
FREE EXAMINATION COUPON

McGraw-Hill Book Co., Inc., 330 West 42d St., New York, N. Y.
You may send me Nádai—**Plasticity**, postpaid, for 10 days' FREE EXAMINATION. I agree to send $5.00 or return the book within 10 days of receipt.

Signed .....

Address .....

City and State .....

Official Position .....

Name of Company .....

(Books sent on approval to retail purchasers in the U. S. and Canada only.) F P.E. 12-31

IS TEMPERATURE a FACTOR IN YOUR PRODUCT?

OFF! OFF! ON! OFF! OFF! ON! ON! OFF!

then CONTROL IT AUTOMATICALLY *with*

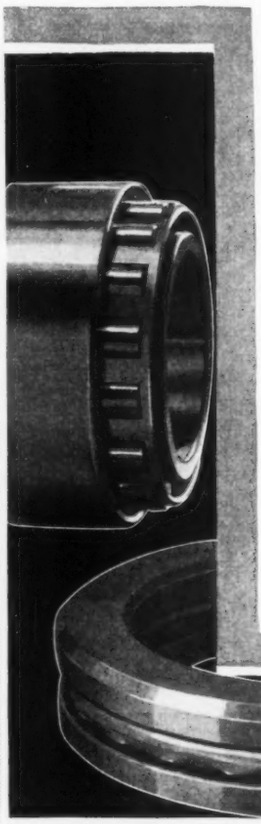
CHACE THERMOSTATIC BIMETAL
"It Bends With the Heat"

Where automatic action is desired, to control temperature, Chace Thermostatic Bimetal used as the active element of your thermostat assures high sensitivity, accuracy, reliability. 1200 degrees Fahrenheit without distortion. Obtainable in sheets, strips or formed to meet your requirements. Consult our Engineering Department.

Manufactured by

W. M. CHACE VALVE CO.
1607 BEARD AVE. DETROIT, MICH.

THE STAMINA of AETNA BEARINGS



BEARING PERFORMANCE often determines the reputation of a machine, its capacity for work, the profitableness of the investment, its dependability and efficiency. It may affect repeat orders, making or breaking reputation and good will.

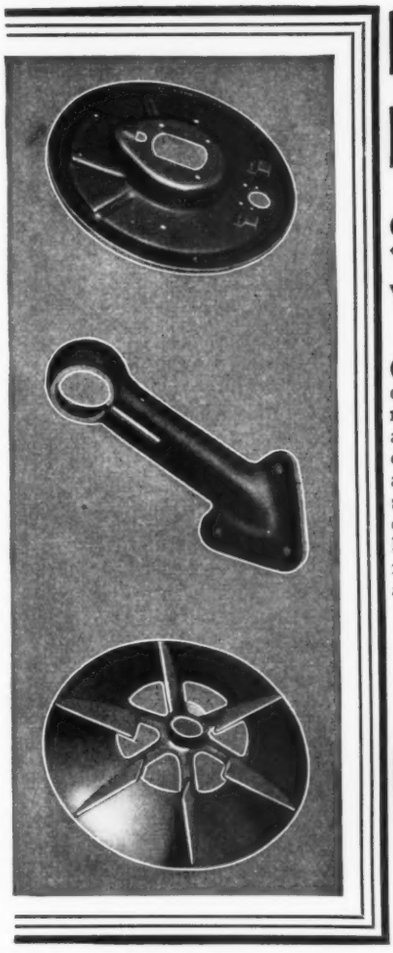
Machinery designers and users can have absolute confidence in Aetna Roller and Ball Thrust Bearings.

Send for your copy of "Ball and Roller Bearings—A Handbook for Designers and Engineers." This valuable 68-page treatise free for the asking.

Aetna Ball Bearing Mfg. Co.
4604 Schubert Ave., Chicago, Ill.

New York Philadelphia Pittsburgh
Columbus Detroit Tulsa San Francisco

SPEED PRECISION STRENGTH
AETNA



Go To Stampings for Economy

Go To Acklin for Stampings

Save Money With Stampings

● Are you trying to reduce production costs? Of course you are. Hundreds of manufacturers have turned to stampings as a means of radically reducing unit costs. Acklin Stampings do not "cheapen" a product; on the contrary, they add strength and reduce weight. Machining operations are materially reduced and because Acklin Stampings are accurately made to blue print, assembly operations are speeded up. Acklin Stampings in steel, brass, aluminum and other metals can be easily adapted to the requirements of your product. Your engineers and ours can work shoulder to shoulder in the solution of the problems you face. There is, of course, no obligation or expense on your part.

● The large Acklin plant is equipped throughout with most modern machinery, including over 150 presses in all sizes and for any type of work. Ample production facilities are guaranteed by the 90,000 square feet of floor space. We will gladly send you the name of your nearest Acklin engineer, on request. The Acklin Stamping Company, Toledo, Ohio. Offices in New York, Chicago and Detroit.

Acklin

Stampings in Steel, Brass, Aluminum and other Metals

PROFESSIONAL SERVICES

TO render still more complete the service of Product Engineering, we have established this classification of "Professional Services" for the cards of consultants on the many problems associated with product engineering.

Use the services of Consultants whose cards appear in this and future issues when you can, and should. Specialists in other technical lines are being invited to make themselves known to you through the medium of similar cards.

J. FRANKLIN BEMIES
Consulting Mechanical Engineer
DESIGNING
Inventions Developed
Machinery Tools Fixtures
Mechanical Inspection Special Devices
198 Broadway, New York City

EDWARD F. CHANDLER
CONSULTING
PRODUCT ENGINEER
Development — Research
420 Lexington Ave., New York City

CLOYD M. CHAPMAN
Consulting Engineer
Design of equipment to meet individual needs, to lower costs and increase production.
105 West 40th St., New York City

Electrical Testing Laboratories
KNOW BY TEST
Mechanical Tests—Chemical Tests
Electrical Tests—Photometric Tests
80th St. and East End Ave., New York.

OTTO A. KUHLER
DESIGN ENGINEER
FOR MODERN METAL PRODUCTS
420 LEXINGTON AVENUE
NEW YORK CITY

NELSON LITTELL
HAMMOND & LITTELL
U. S. and foreign patents.
PRODUCT SURVEYS
Infringement and validity opinion.
Patent and Trade Mark Litigation.
22 E. 40th St., New York City

SCOVELL WELLINGTON & CO.
MANAGEMENT ENGINEERS
Offices in Principal Cities
10 East 40th St., New York City

NORMAN BEL GEDDES
INDUSTRIAL DESIGNER
128 East 37th St., New York City

LURELLE GUILD
INDUSTRIAL-ARTIST
385 Madison Ave.
NEW YORK CITY

Welding, Engineering & Research Corp.
Group Consultation
ON ALL WELDING PROCESSES
— *Technical Board* —
Comfort A. Adams, *Chairman*
C. A. McCune — A. V. DeForest
J. W. Owens — Ancel St. John
J. H. Deppeler — Ernest Lunn
L. S. Moisseiff — F. P. McKibben
25 West 43rd St. — New York, N. Y.

INDEX TO ADVERTISERS

Acklin Stamping Co. 61
Aetna Ball Bearing Mfg. Co. 60
Akron Porcelain Co. 44
Alemite Corp. 3
Allen Mfg. Co. 58
Allis Co., Louis 16
Allis Chalmers Mfg. Co. 14
Aluminum Co. of America 24
American Brass Co. 25
American Record Corp. 50
American Stainless Steel Co. 17
Armstrong Cork Co. 9
Auburn Button Works 40

Bassick Co. 49
Bossert Corp. 47
Bristol Co. 51
Bruning Co., Inc., Charles 19

Carpenter Steel Co. 30-31
Chace Valve Co., W. M. 60
Chicago Molded Products Corp. 58
Cutler-Hammer, Inc. 28-29

Dayton Rubber Mfg. Co. 35
Douglass Fir Plywood Mfrs. 39
Dow Chemical Co. ..... 4th Cover
DuPont de Nemours, E. I. & Co. 45

Egyptian Lacquer Mfg. Co. 43

Federal Bearings Co., Inc. 8
Franklin Die Casting Corp. 50
Fulton Sylphon Co. 27

General Cable Corp. 53
General Electric Co. 20-21-22-23
Gits Bros. Mfg. Co. 38-48

Hoover Steel Ball Co. 18

Johnson Machine Co., Carlyle ..... 2nd Cover

McGraw-Hill Book Co. 42-52-60
Manufacturers' Consulting Engrs. 42
Master Electric Co. 15
Meehanite Institute ..... 3rd Cover
Meyer-Foley Co., Inc. 38
Moccasin Bushing Co. 38
Morse Chain Co. 57

New Departure Mfg. Co. 7
New Jersey Zinc Co. 36
Newton Die Casting Corp. 46
Norton Laboratories 40

Oberdorfer Brass Co., M. L. 48

Parker-Kalon Corp. 54
Philadelphia Gear Works 13
Porcelain Enamel & Mfg. Co. 44
Professional Services 61

Revere Copper and Brass Incorporated 26
Rockford Drilling Machine Co. 50
Roper Corp., Geo. D. 56
Roxalin Flexible Lacquer Co. 44

SKF Industries 32
Scoville Mfg. Co. 12
Searchlight 58
Shakeproof Lock Washer Co. 55
Spaulding Fibre Co., Inc. 6
Standard Pressed Steel Co. 62
Strom Bearings Co. 41
Struthers Dunn, Inc. 52
Synthane Corp. ..... Insert 33-34

Timken Roller Bearing Co. 10

United Chromium Co., Inc. 11

Veeder-Root, Inc. 48
Victor Manufacturing & Gasket Co. 48
Viking Pump Co. 38

Wagner Electric Corp. 37
Westinghouse Electric & Mfg. Co. 4, 5
Wickes Bros. 42
Wickwire Spencer Steel Co. 59

Zobell Electric Motor Corp. 52

This index is published as a convenience to the reader. Every care is taken to make it accurate but *Product Engineering* assumes no responsibility for errors or omissions.

UNBRAKO

"UNBRAKO" "UNBRAKO" "UNBRAKO" "UNBRAKO" "UNBRAKO"

To better appreciate how that "UNBRAKO" Socket Head idea has taken hold and spread just take a look at the five cuts above.

Ever see such fancy styles? Yet each with its Hex Socket was ordered in sufficient quantity to make it a production job—so there is nothing freakish about them.

Needless to say they are "UNBRAKO" quality throughout including the strength of

281,500 lbs. per sq. inch

Could you use one or more of them—or something similar?

Full data in Our "UNBRAKO" Bulletin 429.

STANDARD PRESSED STEEL CO.

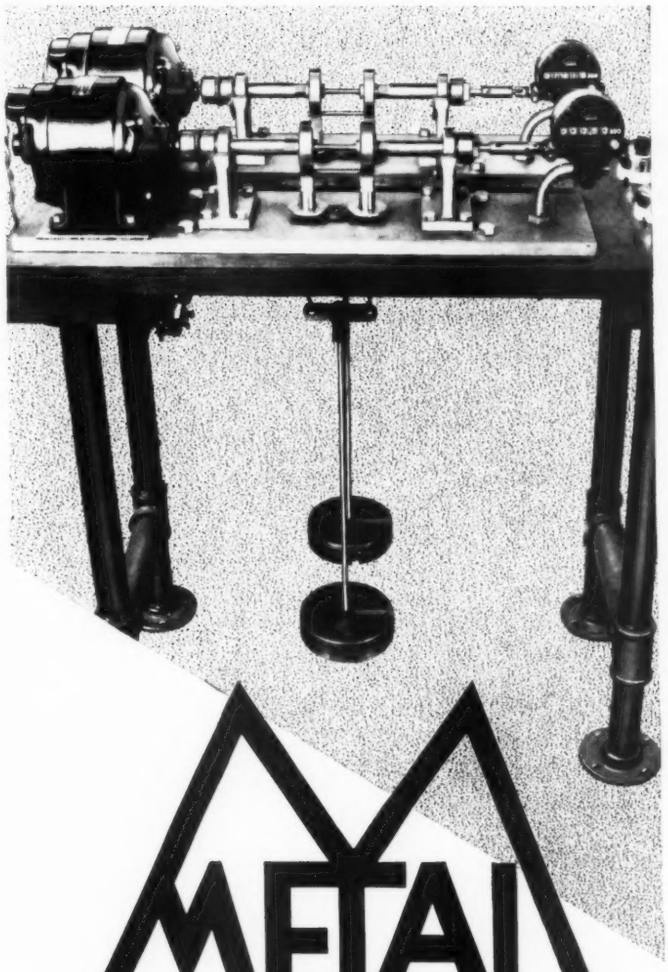
BRANCHES BOSTON CHICAGO DETROIT

JENKINTOWN, PENNA.
BOX 545

BRANCHES NEW YORK SAN FRANCISCO ST. LOUIS

Fatigue Resistance

. . . an answer to the engineer's inevitable question



IN machinery elements there are nine fatigue failures to every one caused by static load. Consequently the fatigue strength or Endurance Limit of material going into machinery parts is necessarily a vital consideration.

The Endurance Limit for any given material is the greatest dynamic stress applied an infinite number of times which does not cause a failure of the metal.

To compare the Endurance Limit of various widely used metals going into machinery, a series of tests were made on the machine here illustrated operating at 1725 r. p. m. Typical specimens were used in each instance.

The results of this test clearly demonstrate the reason for the long service life consistently being obtained by the many Meehanite machine castings now in use.

MEEHANITE FOUNDRIES

ANSONIA, CONN.
Farrel Birmingham Co.
CHATTANOOGA, TENN.
Ross-Meehan Foundries
CHICAGO, ILL.
Greenlee Foundry Co.
CLEVELAND, OHIO
Fulton Foundry & Machine Co.
DETROIT, MICH.
Michigan Valve & Foundry Co.
INDIANAPOLIS, IND.
Indianapolis Casting Co.
MILWAUKEE, WIS.
National Equipment Corp.
PHILADELPHIA, PA.
H. W. Butterworth & Sons Co.
PITTSBURGH, PA.
Rosedale Foundry & Machine Co.
ST. LOUIS, MO.
Banner Iron Works
TRENTON, N. J.
Trenton Malleable Iron Works
TORONTO, ONT.
Dodge Manufacturing Co.
TORONTO, ONT.
Jessop Steel Company

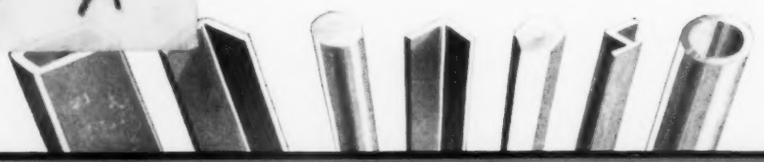
MATERIAL	ENDURANCE LIMIT Fatigue Strength Lbs. per sq. in.
Ordinary cast iron	12,000
Malleable	24,000
Steel, rolled (.12TC)	27,000
Steel forging (.37C)	30,000
Welded Structure	12,000
Meehanite Metal (as cast)	21,000
Meehanite Metal (heat treated)	28,000

Consult the nearest Institute member for the advantages and economy Meehanite can add to your product.

MEEHANITE INSTITUTE

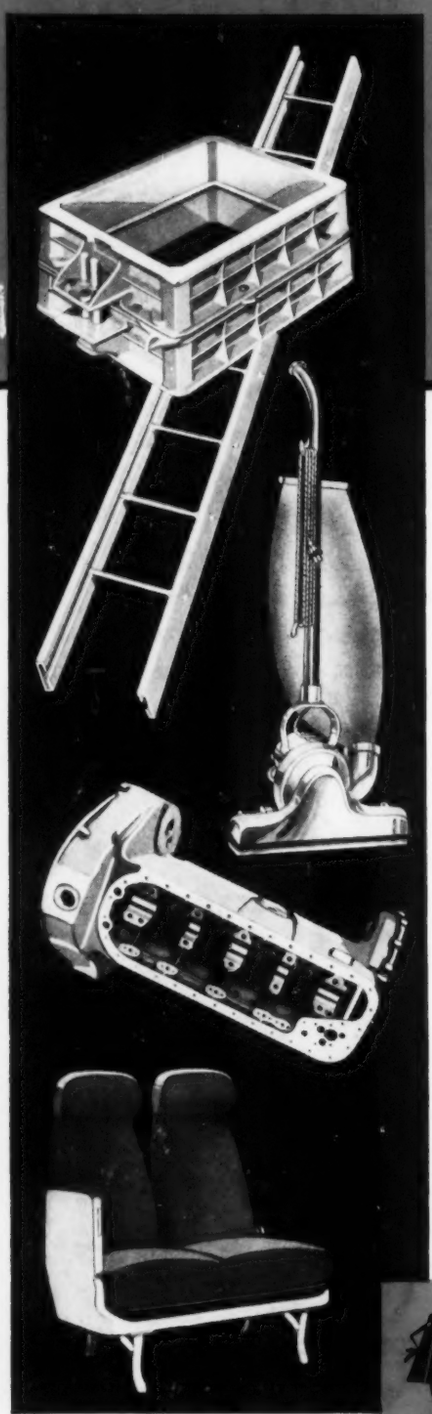
Meehanite Patents: U. S. Patent Nos: 1,449,068 - 1,683,087 - 1,683,086 - 1,731,346. Canadian Patent Nos: 234,933 - 287,903 - 304,254. Other patents pending.

UNIVERSITY OF MICHIGAN
ATT GENERAL LIBRARY
ANN ARBOR MICH



Industry's Lightest Metal

IN WIDE VARIETY OF SHAPES • ¼ THE WEIGHT OF STEEL • MACHINES EASILY • DURABLE • *Good Engineering Properties*



Take useless dead weight out of your products

DOWMETAL lifts the costly burden of dead weight from industry's shoulders. And now, new low prices make it economically applicable to a wide variety of industrial uses.

Imagine a metal ⅓ lighter than other light alloys—less than ¼ the weight of steel—easy to machine—with good strength and durability!

Who knows but that this remarkable metal can add new sales appeal to your product, give you valuable competitive advantages through lighter weight, greater portability, easier handling, lower operating and maintenance costs?

Dowmetal ingots are now available in carload lots at 30c a pound and in l. c. l. lots at 32c.

Write for further information and prices on forms adapted to your product; also for your copy of the new Dowmetal Data Book.

Dowmetal Division
THE DOW CHEMICAL COMPANY
Midland, Michigan

DOWMETAL
MAGNESIUM ALLOYS

NOW YOU CAN MAKE IT OF DOWMETAL

Index photographed at the
beginning for the convenience
of the microfilm user.